3.4 WATERSHEDS, HYDROLOGY, AND FLOODPLAINS

This section discusses a variety of water-related issues as they relate to the proposed action and alternatives and the PALCO Project Area, including stream flow, water quality, and stream channel morphology. Aspects of these issues are addressed in three parts. Section 3.4.1 discusses the climate and watersheds as they exist currently. Section 3.4.2 discusses the impact mechanisms through which the water-related parameters are affected. Section 3.4.3 discusses the environmental effects of each alternative on the watersheds of the Project Area. This section overlaps somewhat with Section 3.6, Soils and Geomorphology, since both sections deal with fine sediments. In this section, fine sediment is treated as a water quality parameter.

3.4.1 Affected Environment

3.4.1.1 Climatic Setting

Humboldt County, including the PALCO Project Area, experiences weather patterns typical of northern coastal California. The chief characteristics of the climate include a distinct wet and dry season and moderate temperatures (National Weather Service, 1998). In general, fog occurs mostly in the summer (June to September) along the coast and is confined to the immediate coastal zone by the coastal mountains, although it penetrates farther into many coastal valleys. Summer fogs are caused by the advection of the marine air layer over the cool Pacific Ocean waters off coastal northern California. Annual occurrence of fog ranges from 40 to 70 days along the coast of Humboldt County (Hardwick, 1973).

Fog-bound coastal area temperatures may have maximum July temperatures of only 50°F, while inland areas not affected by marine air may have maximum temperatures over 100°F (National Weather Service, 1998). In the Eel River watershed, mean minimum annual temperatures vary from 36°F inland to over 40°F along the coast. Mean maximum temperatures in July range from 70°F inland to just over 65°F along the coast (Elford and McDonough, 1974).

Figure 3.4-1 displays the seasonal variation in rainfall and fog influence at Eureka. The higher elevations of the Eel River and Mattole River watersheds receive over 110 inches of precipitation annually. On average, 24-hour totals often reach 8 to 10 inches, and occasionally exceed 16 inches (Mattole Restoration Council, 1995). At comparable elevations, there is a distinct decreasing precipitation gradient from the coast to inland areas. Table 3.4-1 displays the precipitation difference between the Upper Mattole watershed (coastal) and the Eel River watershed (inland).

Runoff from the Eel River basin averages 35 inches annually (Lisle, 1990). Peak flows are generated mostly by large, moderate-intensity storms that last several days during the winter. One of these, which caused the December 1964 flood, produced one of the highest discharges per unit area ever recorded, 9.6 yard per second per square mile ($yd^3/sec/mi^2$) (Wolman and Gerson, 1978). These flows may also be supplemented by snowmelt in the higher elevation areas (Harden, 1978).

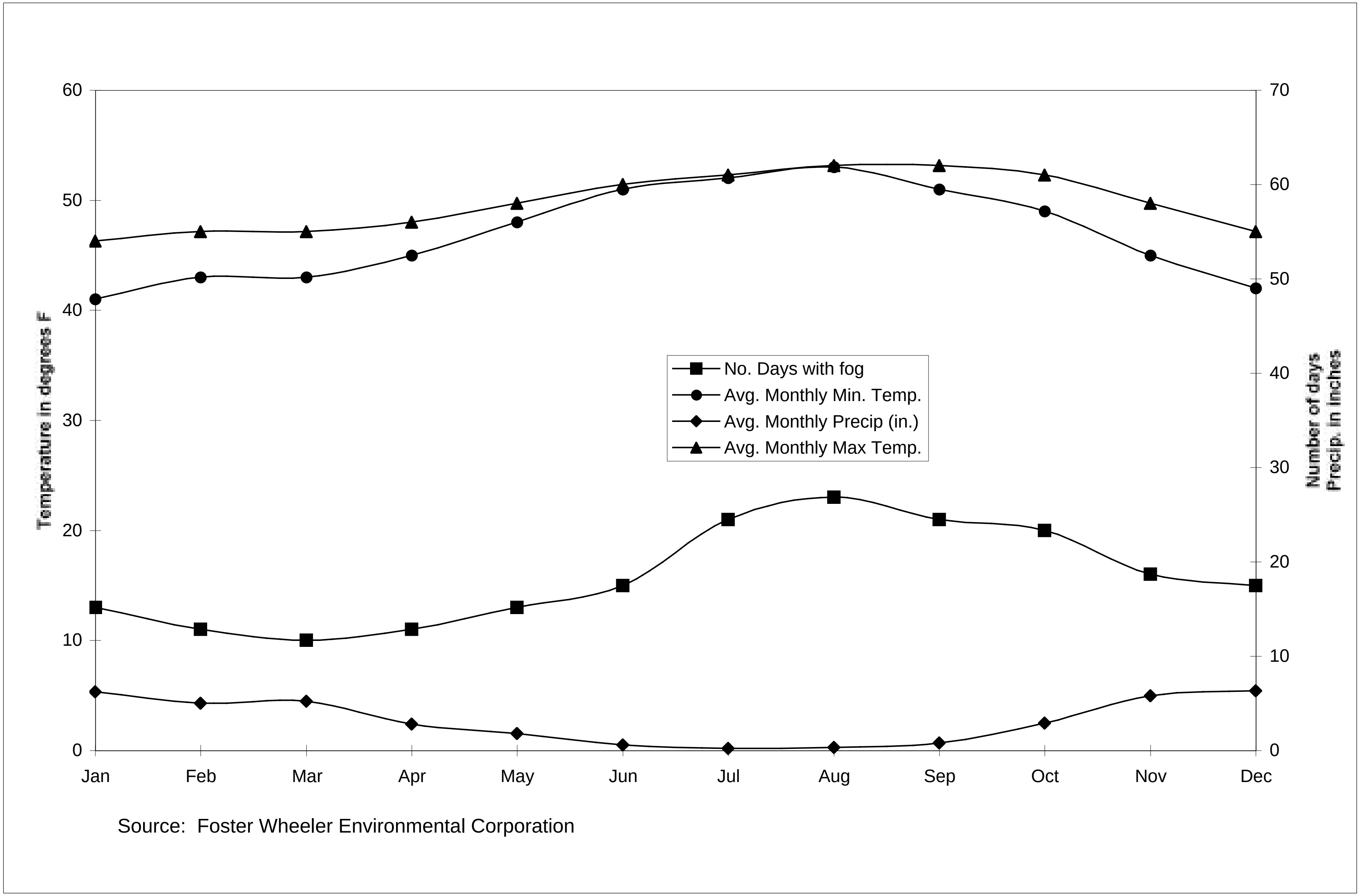

Figure 3.4-1. Climate Data for Eureka, California

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Table 3.4-1. Mean Monthly and Annual Precipitation and Temperatures in Two Humboldt County Coastal and Inland Locations

Month	Inches of Rain (Rohnerville, California)	Inches of Rain (Upper Mattole, California)	Mean Maximum Temperature (°F) at Scotia
January	8.99	15.63	54.8
February	7.87	12.51	57.0
March	6.39	10.46	58.2
April	2.83	5.00	61.2
May	1.52	3.28	63.6
June	0.55	1.07	66.5
July	0.14	0.16	68.8
August	0.10	0.18	69.9
September	0.86	0.79	70.6
October	1.68	5.93	67.1
November	5.44	9.60	61.2
December	6.56	15.65	56.2
Annual	**42.93**	**80.26**	**62.9**

Source: Elford and McDonough, 1974

3.4.1.2 Watershed Descriptions

In the SYP, stream systems in the PALCO Project Area are divided into six major WAAs that encompass approximately 854,900 acres (Figure 3.4-2). The WAAs were created by PALCO for analysis in the HCP. WAA boundaries are based in part on the boundaries of “planning watersheds” delineated by the State of California. Table 3.4-2 presents the general features of the WAAs and the percentage of each that is owned by PALCO. Overall, PALCO owns approximately 209,834 acres or about 24 percent of the land in the six WAAs. The WAAs are climatically, topographically, and hydrologically similar, with a few differences due to watershed size and proximity to the coast.

The six WAAs comprise 19 HUs (Figure 3.4-2). These 19 HUs are further divided into 94 planning watersheds. Planning watersheds are designated by a unique number based on the main river basin. These watersheds may include more than one tributary to the mainstem river. The climatic and topographic differences among HUs and planning watersheds within the WAAs are probably negligible, due to their close proximity and similar topography; however, no site-specific data are available to verify this assumption. Most available information is at the scale of HUs or WAAs. Effects may occur at the planning watershed scale that are not apparent at larger scales. However, analysis of effects at the planning watershed scale requires more extensive and detailed data than are now available (prior to Level II watershed analysis). Therefore, the HU is the smallest areal unit analyzed in this document. However, we can speculate on the effects at the planning watershed scale, to some degree. The planning watershed designation was used for evaluation if specific information was available at this level of detail.

Table 3.4-2. PALCO Project Area WAA Descriptions

WAA	Size in Acres	PALCO Ownership in Acres (% of Total Watershed)	Elevations	Major Streams
Humboldt Bay	128,448	38,985 (30%)	Sea level to 2,800 feet	• Jacoby Creek • Freshwater Creek • Elk River • Salmon Creek
Mad River	332,077	3,904 (1%)	Sea level to 5,000 feet	• Mad River
Yager	84,541	33,730 (40%)	400 to 3,300 feet	• Yager Creek • Lawrence Creek
Van Duzen	55,361	24,934 (45%)	40 to 3,200 feet	• Van Duzen River
Eel	427,468	73,862 (17%)	Sea level to 6,000 feet	• Eel River including the North, Middle, and South Forks
Bear-Mattole	159,054	30,580 (19%)	Sea level to 4,000 feet	• Bear River • Mattole River
Total	**854,852**	**202,091 (24%)**		

Source: Foster Wheeler Environmental Corporation

Table 3.4-3 summarizes hydrologic data by watershed. For many of the HUs there are no flow data available, and data that are available vary in quality. General hydrologic aspects of WAAs in the Project Area and specific HUs are discussed below. The WAAs are generally presented in order, from north to south.

Mad River WAA

The Mad River watershed is the northernmost drainage in the Project Area (Figure 3.4-2). Its headwaters are in the Six Rivers National Forest, at the southern end of South Fork Mountain. As with several of the other North Coast watersheds, the Mad River watershed has an elongated shape. It has a very long trunk stream, but relatively short tributaries, and is oriented southeast to northwest. Its drainage area is about 310,400 acres and ranges in elevation from sea level to about 5,000 feet. There is one dam on the Mad River, at Ruth Reservoir, located at river mile 69. The river occupies a meandering pathway with associated (recent) flood terraces.

Precipitation at the headwaters of the Mad River averages about 60 inches per year, while at the mouth, near Arcata, the average precipitation is 40 inches per year (BLM and FWS, 1981). Diversions for municipal and industrial use occur near the mouth, just above Arcata. The estimated 100-year flood is about 100,000 cfs, while the 2-year flood is about 18,000 cfs.

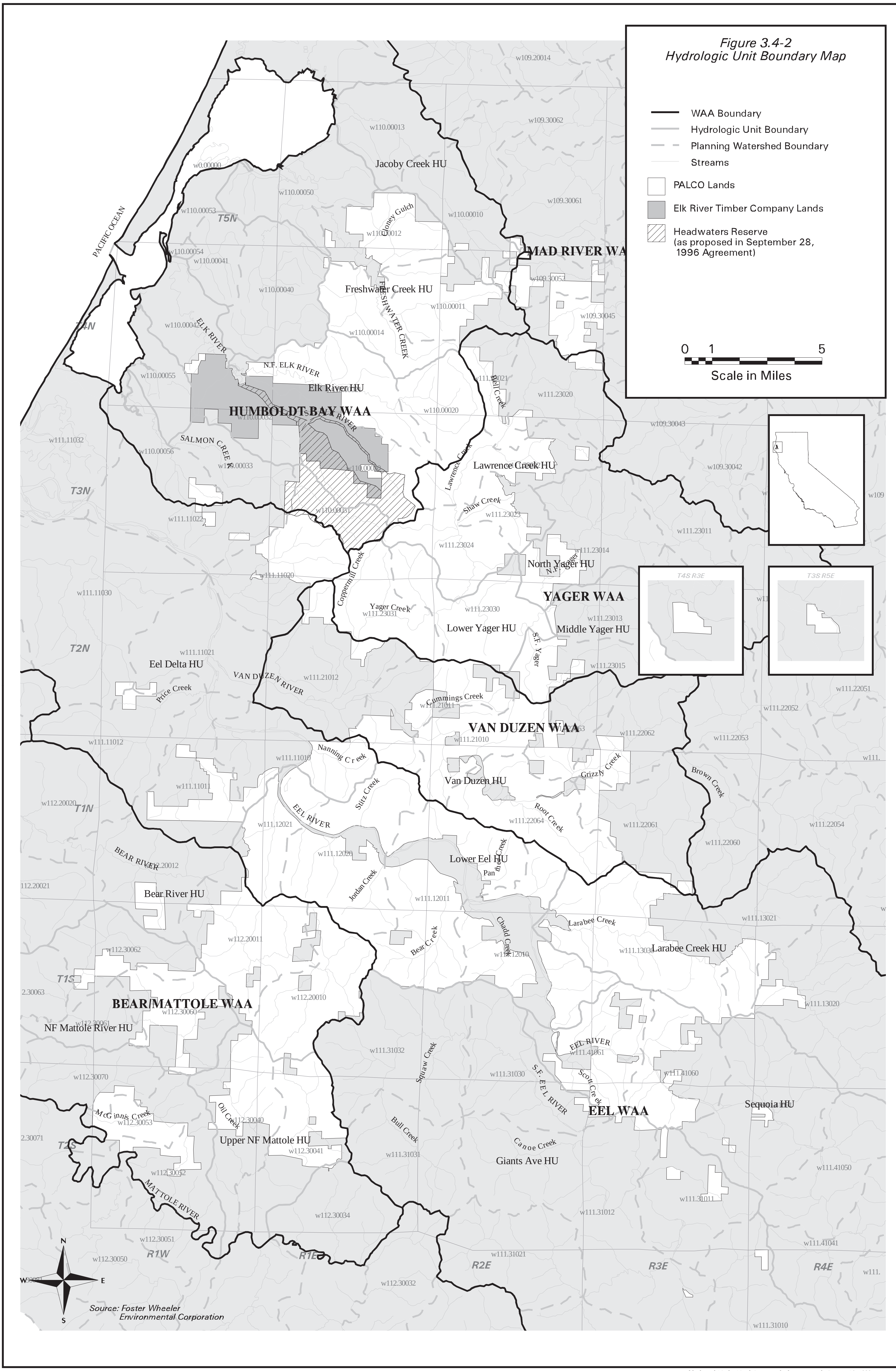


Figure 3.4-2
Hydrologic Unit Boundary Map

Table 3.4-3. Hydrologic Data by Watershed

Stream	Drainage Basin Area (mi^2)	USGS Station #	Annual Mean (cfs)	Annual Mean/Unit Area (cfs/mi^2)	Lowest Annual Mean (cfs)	Peak Discharge-Daily Mean (cfs)	Peak Discharge/ Unit Area (cfs/mi^2)	Month/ Year	Low Discharge Daily Mean (cfs)	Month/ Year
Bear River	104	No Data	No Data	No Data	No Data	No Data		No Data	No Data	No Data
Mattole River near Petrolia[1/] (1912-1994)	240	11469000	1,281	2.6	157	55,200		Dec-64	17	Sep-77
Eel River[1/] (Upstream of PALCO) 1923-1994	2,107	11475000	4,417	2.1	260	434,000	205.9	Dec-64	1.2	Sep-77
Eel River [1/] (PALCO property line) 1911-1994	3,113	11477000	7,127	2.3	563	648,000	208.2	Dec-64	12	Aug-24
Van Duzen River[1/] (1951-1994)	222	11478500	839	3.8	66	33,900	152.7	Dec-64	4.4	Sep-92
Salmon Creek	20	No Data	No Data	No Data	No Data	No Data		No Data	No Data	No Data
Elk River[2/] (Near Falk) (1958-1967)	44	11479700	84	1.9	55	2,770	62.7	Dec-64	0.4	Oct-61
Freshwater Creek	43.2	No Data	No Data	No Data	No Data	No Data		No Data	No Data	No Data
Jacoby Creek[2/] (1955-1964)	6	11480000	15	2.6	10	548	94.5	Dec-55	0.7	Nov-59
Yager Creek[2/] (1953, 1960, and 1965-1972)	127	11479000	382	3.0	232	9,400	74.0	Mar-63	2.3	Oct-69

1/ USGS, 1994.

2/ USGS Historical Surface Data for Discontinued Gaging Stations

Source: Foster Wheeler Environmental Corporation

Two HUs contain PALCO lands: the Butler Valley and Iaqua Buttes HUs. PALCO owns approximately three percent of the Butler Valley HU, and four percent of the Iaqua Buttes HU, or 1,805 and 1,462 acres, respectively. Drainage density, an indicator of stream vulnerability to sediment influx, is 3.8 and 5.6 mi/mi^2 for the Butler Valley and Iaqua Buttes, respectively.

Humboldt Bay WAA

This WAA is composed of four major southeast-northwest-trending HUs that drain into Humboldt Bay. These HUs include from north to south: Jacoby Creek, Freshwater Creek, Elk River, and Salmon Creek. The upper portions of the Little South Fork Elk River and Salmon Creek watersheds form the proposed Headwaters Reserve. The elevation range within each watershed is similar, from sea level to about 1,900 feet. The total area of the Humboldt Bay WAA is 128,448 acres, with about 30 percent in PALCO's ownership. Because of its proximity to the coast and the orientation of the valleys, the Humboldt Bay WAA is affected more by coastal fog than other WAAs.

The rivers in this WAA are typified by relatively high gradients and large flows (BLM and FWS, 1981). Average annual precipitation ranges from 40 inches near Humboldt Bay to 60 inches in the higher elevations. The discharge records for these rivers are incomplete or missing altogether. Stream gages were located on Jacoby Creek and on the Elk River for a short time in the 1950s and 1960s. Based on similarity in climate, vegetation, and topography, runoff characteristics are believed to be comparable to similar-sized tributaries in other WAAs. The drainage density is approximately 3.7 mi/mi^2.

Eel WAA

The Eel WAA is the largest WAA in the Project Area, consisting of 427,468 acres, with about 74,000 acres in PALCO ownership (Figure 3.4-2). The PALCO lands are mostly within the middle and lower portions of the Eel watershed, downstream of the junction with the South Fork Eel. It should be noted that the WAA, as delineated in the SYP and Watershed Analysis Report, does not include significant portions of the actual watershed. The entire watershed area is 2 million acres. Elevations range from sea level to about 6,000 feet at the headwaters of the Middle Fork of the Eel River. Rainfall averages 60 inches per year at lower elevations, and reaches 110 inches per year at higher elevations (BLM and FWS, 1981).

The headwaters of the Eel River are in the interior coast ranges in Mendocino and Trinity counties, and include three main forks plus the mainstem Eel River. The South Fork generally flows northwest from Lake Pillsbury, a reservoir, to the junction with the Middle Fork at Dos Rios. Water is diverted out of the basin to the Russian River. The Middle Fork originates in the high country of the Yolla Bolly/Middle Eel Wilderness, flows roughly southwest, and then turns abruptly west to meet the mainstem Eel River. The North Fork flows southeast from its headwaters, then turns southwest and finally west to meet the mainstem Eel River. Numerous large tributaries upstream of the town of Weott are not discussed in this EIS/EIR, because most PALCO lands are north of Weott.

Brown and Ritter (1971) conducted an extensive study of sediment discharge within the Eel River watershed. They determined that the suspended sediment discharge increases downstream, unlike most rivers (Figure 3.4-3). The average annual suspended sediment load is 10,000 tons/mi^2 (Brown and Ritter, 1971), which is one of the highest sediment yields in the world.

Van Duzen WAA

The Van Duzen River is a tributary to the Eel River (Figure 3.4-2). Its mouth is about 4 miles downstream from Scotia. As defined in the SYP, the WAA excludes the headwaters of the Van Duzen, and consists of about 55,400 acres. However, the total area of the Van Duzen watershed is about 189,000 acres; 25,000 acres is owned by PALCO. The Van Duzen River flows northwest from its headwaters, then turns west and flows through deeply incised valleys that have an average slope of 59 feet per mile (1.1 percent). Bank cutting and slides are common along the Van Duzen River between Carlotta and Bridgeville. Although the elevation of the entire watershed ranges from near sea level to 5,000 feet, the portion on PALCO lands is relatively low. Some planning watersheds within the Van Duzen WAA include Cummings, Hely, Stevens, Root, and Grizzly creeks.

Average annual precipitation in the Van Duzen WAA is 64 inches, while average annual runoff is 995,000 acre-feet at Bridgeville. The average annual suspended sediment load is 6,760 tons/mi^2 (1941 to 1975). Stream density is 3.4 mi/mi^2.

Yager Creek WAA

Yager Creek is a tributary to the Van Duzen River. The area of the WAA is approximately 85,000 acres, and over one-third is under PALCO ownership (Figure 3.4-2).

Yager Creek flows from its headwaters, mostly in prairie lands, generally westward through deep valleys, with vegetation changing to redwood forest. Like many rivers in the Coast Range, it is entrenched and flows along small meanders. Two main forks, the North Fork and South Fork of Yager Creek, are present in the east portion of the watershed and are mostly outside of PALCO's ownership. Another tributary of equal importance is Lawrence Creek, which flows north to south and joins Yager Creek downstream of the junction of the North and South forks.

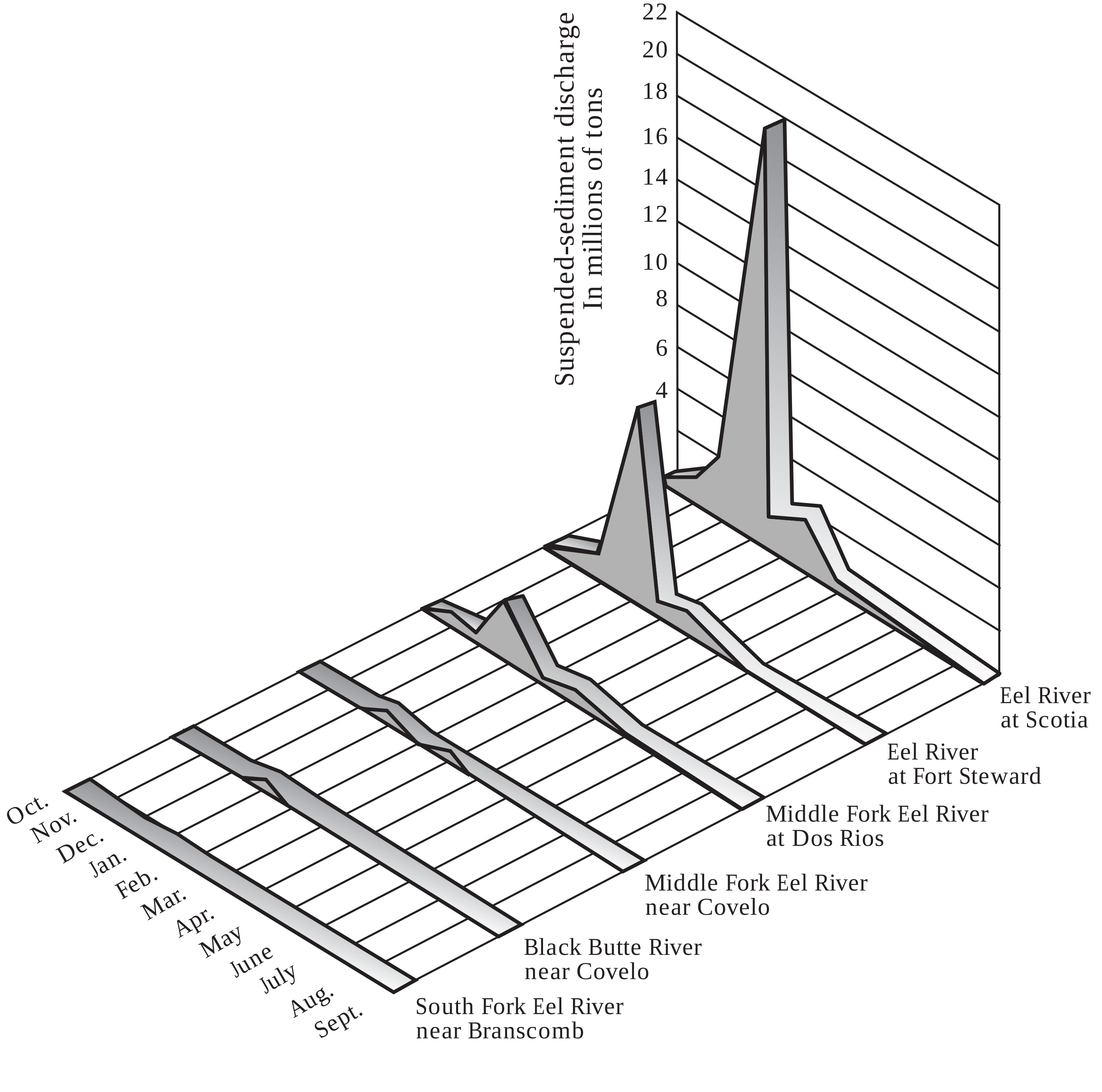
Larger HUs within the WAA include Lawrence Creek and the North, Middle, and South forks of Yager Creek; some planning watersheds include Strawberry, Blanton, Allen, and Cooper Mill creeks. Elevations range from near 400 feet to about 3,200 feet. Stream density is relatively high, at 3.8 mi/mi^2. Being farther inland, the Yager Creek WAA is influenced very little by coastal fog (BLM, 1981).

There are very little water and sediment discharge data for Yager Creek. However, based on the general physiography, climate, and location of the creek, it can be assumed to be hydrologically analogous to similar-size watersheds in the vicinity (e.g, Bear River).

Bear-Mattole WAA

The Bear-Mattole WAA lies between the Eel River WAA and the coast. This WAA contains two major watersheds: the Bear River and the Mattole River. The area of the WAA is approximately 160,000 acres, of which PALCO owns 25 percent of the Bear River watershed and 7.5 percent of the Mattole River watershed. Both watersheds have a mixture of prairie and forest and are not significantly influenced by coastal fog due to their orientation relative to the coastline (BLM, 1981).

The Mattole River has two major forks: the mainstem and Bear Creek (Figure 3.4-1). Both flow northwesterly. The watershed is unique in that its headwaters (both forks) are a short distance from the ocean. The total length of the mainstem Mattole is 63 miles. The total area of the Mattole watershed is about 319,360 acres. Elevation ranges from sea level to 4,200 feet. In the upper reaches, the river flows through an open alluvial plain. Much



Source: Foster Wheeler Environmental Corporation

Figure 3.4-3.
Variation in Suspended Sediment Loads Within the Eel River Watershed

of its length, however, is in entrenched meanders. Downstream of the junction with the North Fork Mattole River, the channel and valley narrow, and the river flows southwest toward the sea. PALCO's property is located within the North Fork Mattole River and the Upper North Fork Mattole HUs. The North Fork flows west and southwest in deep canyons of the Coast Range. The river and its tributaries are entrenched in their valleys and have numerous small meander bends. The valley of the North Fork widens upstream of Petrolia, about 2.3 miles above the junction with the main fork of the Mattole River. The Upper North Fork Mattole River flows roughly north-south, through deeply entrenched valleys, joining the Mattole at Honeydew.

Average annual precipitation in the Mattole River watershed is 40 inches near Cape Mendocino and reaches 90 inches near Shelter Cove (BLM and FWS, 1981). A small amount of water is diverted for irrigation (BLM and FWS, 1981). The Mattole River has an estimated 100-year flood of 99,000 cubic feet per second (cfs), while the two-year flood is about 40,000 cfs (BLM and FWS, 1981). Annual suspended sediment yield averages 9,517 tons/mi^2 (BLM and FWS, 1981). Stream density across the entire WAA is approximately 3.4 mi/mi^2.

The Bear River is 24.3 miles long; it has a 66,000-acre drainage area and flows westward across the Coast Range to the Pacific Ocean. Elevation in the watershed ranges from sea level to just under 3,000 feet. There are no data on water or sediment discharge on the Bear River. However, its headwaters are underlain by a shear zone that is part of the Mendocino Triple Junction (see Section 3.5, Geology and Mineral Resources). It is likely that natural sediment production is high and probably similar in nature to the Mattole River.

3.4.1.3 Water Quality of the Project Area

In this analysis, the physical properties and chemical constituents of water serve as the primary means for monitoring and evaluating water quality. Water quality is measured by many parameters, but for the areas of concern, the most important parameters are stream water temperature, sediment-related water parameters such as suspended sediment and turbidity, dissolved oxygen, nutrients such as nitrates and phosphates, pesticides/herbicides, and fecal coliform (bacteria). The existing conditions and regulatory background of the Project Area are discussed first. Section 3.4.2.3 discusses water quality impact mechanisms. A detailed data set of water quality parameters for specific sites within the Project Area is available through the Klamath Resource Information System (1998).

Regulatory Background

The water quality in the North Coast Region of California generally meets or exceeds the water quality objectives of the region (NCRWQCB, 1996). In most cases, it is sufficient to support and in some cases enhance the beneficial uses assigned to waterbodies. Cool water temperatures from the rugged coastal forested regions of the North Coast, in addition to the physical habitat qualities of the streams, have supported anadromous and resident fish. Naturally high turbidity exists from the high annual rain and the unstable and erodible soils of the area (NCRWQCB, 1996). However, impacts from numerous land-use activities have degraded water quality in many streams; specific impact mechanisms are discussed in Section 3.4.2.2.

The California NCRWQCB Basin Plan directly addresses water quality guidelines for logging, road construction, and associated activities (NCRWQCB, 1996). However, the following water quality objectives for the basin are considered of particular importance in protecting beneficial uses from unreasonable potential effects of the proposed project. The Basin Plan states the following (NCRWQCB, 1996):

1. "Waters shall be free of coloration that causes nuisance or adversely affects beneficial uses.

2. Turbidity shall not be increased more than 20 percent above naturally occurring background levels.

3. Waters shall not contain taste or odor producing substances in concentrations that impart undesirable tastes or odors to fish flesh or other edible products of aquatic origin that cause nuisance or adversely affect the beneficial uses.

4. Waters shall not contain floating material, including soils, liquids, foams, and scum, in concentrations that cause nuisance or adversely affect beneficial uses.

5. Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses.

6. The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.

7. All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.

8. Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

9. The bacteriological quality of waters of the North Coast Region shall not be degraded beyond natural background levels.

10. The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.

11. At no time or place shall the temperature of any COLD water be increased by more than 5°F above natural receiving water temperature."

The NCRWQCB is responsible for implementing and regulating water quality control plans for the North Coast Hydrologic Unit Basin Planning Area of northern California. The Basin Plan provides a definitive program of actions designed to preserve and enhance water quality and to protect beneficial uses of water in the North Coast Region, relative to the above objectives. The NCRWQCB has listed the following basins as "water quality limited" for temperature and/or sediment. This designation is assigned to streams where established water quality objectives as specified in the Basin Plan are not being met or where beneficial uses are not protected. Impaired waterbodies and their respective HUs in the Project Area are shown in Table 3.4-4.

Table 3.4-4. Clean Water Act, Section 303(d) List of Impaired Waterbodies that Flow through PALCO Lands

River	Listed Pollutant	TMDL Completion Date
Eel River (Middle Main Fork)	Sediment, Temperature	1999
Eel River (Delta)	Sediment	2004
Van Duzen River (Below Bridgeville)	Sediment	1999
Yager Creek	Sediment	1999
Mattole River	Sediment, Temperature	2002
Mad River	Sediment, Turbidity	2007
Freshwater Creek	Sediment	2010
Elk River	Sediment	2011

Source: Foster Wheeler Environmental Corporation

The "water quality limited" listing also requires the assessment of watershed impacts, identification of actions needed to attain water quality standards, and development of an implementation and monitoring approach that is consistent with the federal CWA requirements. TMDLs are required for water quality-limited streams, as stated in Section 303 of the CWA. TMDLs are planning documents that provide a framework for identifying causes of watershed impairment and developing implementation strategies for restoring watershed health. However, they have not yet been developed for these watersheds. The current schedule for completion of TMDLs for individual WAAs within the Project Area ranges from 1999 to 2011 (Table 3.4-4). Because the proposed HCP/SYP is not designed specifically to address impaired waters to meet the water quality criteria, additional restrictions and BMPs may be required later by the TMDL process. These future restrictions could conflict with some management components of the proposed HCP/SYP. Such future effects of the Clean Water Act enforcement are beyond the scope of this document and thus will not be addressed here.

In October 1996, the Mattole Sensitive Watershed Group nominated the Mattole River watershed for classification as a sensitive watershed under Title 14 of the CCR, Sections 916.8, 936.8, and 956.8 of the FPR (CDF, 1997a). Primary reasons stated by the Mattole Sensitive Watershed Group for the nomination included seasonally high water temperatures that have resulted in recorded mortalities of juvenile chinook salmon in the lower river, excessive fine sediments in streams, and depletion of late-seral forests in the watershed below minimum levels (i.e., less than 15 percent of total area). These conditions are attributed to extensive timber harvest and road building in the watershed (Mattole Sensitive Watershed Group, 1996). The Board of Forestry did not accept the nomination of the Mattole River as a sensitive watershed.

Water Supply

Several incorporated and unincorporated domestic water supplies are located within or near the boundaries of the Project Area. The community wells are located on the alluvial floodplain of the Yager Creek watershed, south of the town of Fortuna. Two community wells supply water for about 1,100 people. In addition, non-potable and potable water are supplied by two streams in the Humboldt Bay WAA. Approximately 20 to 30 households have water intakes in the North Fork Elk River, and more than 50 households have intakes in Freshwater Creek.

The reauthorized Safe Water Drinking Act of 1996 requires every state to develop and implement an assessment, known as a source water assessment program, of all groundwater and surface water drinking water sources. This includes identifying activities in the water protection area that could degrade water quality. The following activities are required as part of the program: delineation of the source water protection area, contaminant inventory, susceptibility analysis, public access, and public participation (EPA, 1998).

Water Quality Parameters

TEMPERATURE

Stream temperature is influenced by many factors including latitude, altitude, season, time of day, flow, channel width and depth, groundwater flow, stream shading from topography or vegetation, and coastal fog (MacDonald et al., 1991). The climate along the coast (i.e., Humboldt Bay WAA) is cooler due to the coastal fog influence, which also helps maintain cooler water in these areas (National Weather Service, 1998). The water temperatures increase substantially farther inland where air temperatures in the summer can easily exceed 100°F (National Weather Service, 1998).

The highest temperatures occur during the summer months and are of primary concern because they are a limiting factor for salmon and steelhead trout (MacDonald et al., 1991). Consequently, water temperatures on PALCO lands are being measured during the warmest period of the year (June to September). No water temperature data exist for other seasons. Volume II Part F of the Proposed HCP/SYP presents water temperature data collected by CDFG (1997) and PALCO (1996) at various sites throughout the five WAAs in the PALCO Project Area. The data (1995 to 1996) were collected using continuous temperature monitoring instruments placed in pool habitats at an average depth of one foot.

Water temperature criteria for freshwater organisms are typically expressed by mean and maximum thermal conditions. Mean temperature criteria for all life stages protect growth and reproduction functions, while maximum temperature criteria protect against lethal conditions. The maximum weekly average temperature (MWAT) criterion is widely recommended as a means of developing species-specific indicators of thermal stress (Brungs and Jones, 1977; Armour, 1991; Nielsen, 1996). The physiological optimum temperature (OT) and the ultimate upper incipient lethal temperature (UUILT) are required to determine MWAT criteria for different salmonid life stages. OT is a documented optimal temperature for a particular life stage or function. While the OT can be measured for numerous physiological functions, growth appears to be the most sensitive function. The UUILT is the transition point between the highest temperatures to which an organism can be acclimated and the lowest of the extreme upper temperatures that will kill the organism.

MWAT criteria for a specific species of salmonid and its associated lifestage are calculated as follows:

$$MWAT = OT + \frac{UUILT - OT}{3}$$

The MWAT criteria for a specific species of salmonid and its associated lifestage can vary depending upon the acclimation temperature and UUILT value used (Section 3.8). The resource agency aquatic habitat needs and biological matrix (RAAHNBM) has determined an MWAT value of 16.8°C for late summer rearing juvenile coho salmon.

The MWAT value for a site is the mathematical mean of multiple, equally spaced, daily temperatures over seven days (Brungs and Jones, 1977). The MWAT value determination measured by continuous temperature monitoring instruments can then be compared with MWAT criteria for specific aquatic organisms. MWAT values (Table 3.4-5) were determined for temperatures recorded at 15 monitoring stations in the Project Area during the summer of 1995. 1996 data were determined from 9 of the 15 stations from 1995, plus 14 new monitoring stations. In general, exceedance of the MWAT criteria occurred on several streams in late July or early August during both years studied. MWAT values varied between 14 and 18°C, although extreme values of 13.5 and 23.3°C were calculated. Higher temperatures were recorded in 1996 than in 1995 due to a warmer summer. Results for 1996 indicate MWAT values exceeded RAAHNBM MWAT criteria for coho salmon at eight locations, including Bear, Canoe, Larabee, and Rodgers creeks, North Fork Yager Creek, the Bear River, and the North Fork Elk River (Table 3.4-5). The high MWAT values are generally associated with the location of monitoring stations in stream reaches with less than 30 percent canopy cover. These general patterns represented by the high MWAT values indicate that stream shading (canopy) is a critical indicator of stream temperatures in all the watersheds, including the coastal watersheds (Humboldt Bay WAA).

SEDIMENT

Two of the most common water quality parameters measured and monitored for sediment are suspended sediment and turbidity. Both are related to sediment delivery and transport in hydrologic systems. Streams that exceed the water quality objectives for sediment-related water quality objectives would have high suspended-sediment delivery rates and/or turbidity.

CDF has listed the Elk River watershed (Elk River HU), Freshwater Creek watershed (Freshwater Creek HU), Jordan Creek watershed (Lower Eel HU), Bear Creek watershed (Lower Eel HU), and Stitz Creek watershed (Lower Eel HU) as cumulatively impacted by sediment. To obtain approval of a THP for these watersheds, an applicant must demonstrate no reasonable potential to add to past, present, or reasonably foreseeable cumulative effects to anadromous fish habitat, including coho salmon habitat, and no impeding of recovery of coho salmon and their habitat. The mitigation for these watersheds may include zero net discharge (see discussion below). For the THP area, the plan must include development of monitoring stations, avoidance of winter road construction, and the use of a disturbance index at the planning watershed level. Explicit mitigation measures for each cumulatively affected watershed are described in Appendix H.

In addition, CDF and CDFG have maintained a policy of “zero net discharge” of sediment to watercourses in the Mattole River watershed since 1992. Zero net discharge policy requires that before any new THPs are approved, a net decrease in sediment discharge following logging operations must be demonstrated.

SUSPENDED SEDIMENT

Suspended sediment is the portion of the sediment load suspended in the water column. The grain size of suspended sediment is usually less than one mm diameter (clays and silts), while particles greater than one mm can be transported as suspended sediment (Sullivan et al., 1987).

Table 3.4-5. Stream Temperature by Planning Watershed[1/] (PALCO, 1998)

WAA	HU	Planning Watersheds	Stream-Station Name	Monitoring Station Number	Start Date of 7-Day Average	MWAT (OC)	Canopy Closure
Humboldt	Freshwater Creek	Freshwater	Freshwater Creek	33	7/25/96	16.19	75
		Camp 12	Freshwater Creek	36	7/25/96	16.19	96
		Camp 12	S. Fork Freshwater Creek	37	8/1/95	14.59	94
		Eddysville	Cloney Creek	92	7/27/95	15.42	
	Elk River	Turkey Foot	N. Branch Elk River	91	8/1/95	14.47	
		Turkey Foot	N. Branch Elk River	91	7/25/96	14.75	
		Scout Camp	N. Fork Elk River	90	8/1/95	14.47	
		Scout Camp	N. Fork Elk River	90	7/25/96	17.82	
		Scout Camp	N. Fork Elk River	14	7/25/96	17.82	93
	Salmon Creek	Upper Salmon	Salmon Creek	12	7/28/95	14.03	93
		Upper Salmon	Salmon Creek	12	7/25/96	14.83	
Yager	S. Fork Yager Creek	Bald Jessie	S. Fork Yager Creek	68	8/1/95	17.13	
	N. Fork Yager Creek	N. Fork Yager Creek	N. Fork Yager Creek	11	7/24/96	22.86	10
		Camp	Cooper Mill Creek	66	7/15/95	15.33	
		Camp	Cooper Mill Creek	66	7/24/96	14.85	
		Side 8	Corner Creek	88	6/27/95	13.47	
		Side 8	Corner Creek	88	7/25/96	14.48	
	Lawrence	Bell Creek	Bell Creek	117	7/24/96	14.89	96
Van Duzen	Van Duzen	Cummings	Cummings	108	7/24/96	15.57	
		Root Creek	Root Creek	3	7/24/96	15.26	97
Eel	Eel Delta	Dean Creek	Nanning Creek	4	7/26/95	16.58	63
		Newberg	Strongs	93	7/14/95	15.53	95
	Lower Eel	Pepperwood	Bear Creek	89	7/15/95	18.9	
			Bear Creek	89	7/25/96	17.45	
		Scotia	Monument	106	7/25/96	15.79	96
		Stafford	Twin Creek	95	7/14/95	15.97	
			Twin Creek	95	7/24/96	16.33	
	Larabee	Larabee	Larabee Creek	2	7/24/96	23.32	11
			Scott Creek	99	7/25/96	14.38	
	Giants Avenue	Weott	Bull Creek	100	7/15/95	18.9	26
			Cow Creek	105	7/24/96	16.38	97
		Fox Camp	Squaw Creek	102	7/19/95	16.4	95
			Squaw Creek	102	7/24/96	16.19	
		Myers Flat	Canoe Creek	103	8/1/95	16.14	82
			Canoe Creek	103	7/24/96	17.96	
Bear-Mattole	Bear River	Happy Valley	Bear River	97	7/25/96	17.37	
		Beer Bottle	Bear River	1	7/25/96	19.54	3
	N. Fork Mattole River	Rainbow	Rodgers Creek	29	7/25/96	17.94	32

1/ Monitoring Station Map is available in PALCO HCP/SYP: Vol. V, Map 17 (PALCO, 1998).
Source: Foster Wheeler Environmental Corporation

Long-term annual suspended sediment information was available from one location within the Humboldt Area, the Eel River at Scotia (United States Geological Survey [USGS], 1994). The suspended sediment yield is greatest at times of highest flow rate (January through March). On average, the suspended sediment rate reaches a peak of 82,700 tons of sediment/day in January and drops to a low suspended sediment rate of less than 2,000 tons/day in March to less than two tons/day from July to October (USGS, 1994). The suspended sediment record for 1993 to 1994 reflects a low flow discharge year for this location. The annual mean flow discharge for 1994 was 2,945 ft^3/s compared to an annual mean of 7,127 ft^3/s for this location over an 83-year period (USGS, 1994).

Peak daily suspended sediment loads recorded in February 1980 for the following streams were as follows: Lower Yager Creek (16,949 tons per day), Middle Fork Yager Creek, and North Fork Yager Creek (8,373 tons per day) and Lawrence Creek (410 tons per day) (Winzler and Kelly, 1980). In the Upper Van Duzen River, east of PALCO ownership, the average yearly suspended sediment discharge was 38,294 tons per square mile from 1941 to 1975 (Kelsey, 1980).

TURBIDITY

Turbidity refers to the amount of light scattered or absorbed by a fluid. In streams it is usually a result of suspended particles of silts and clay, but also organic matter, colored organic compounds, plankton and microorganisms. It is measured in nephelometric turbidity units (NTUs). Although turbidity in a stream is highly variable and the relationship between turbidity and suspended sediment must be determined for each watershed, turbidity is regarded as the single-most sensitive measure of the effects of land use on streams, mainly because relatively small changes in suspended sediment can cause a large change in turbidity (MacDonald et al., 1991). There is no specific turbidity information for the Project Area.

DISSOLVED OXYGEN

Dissolved oxygen (DO) refers to the concentration of oxygen dissolved in water. Adequate DO levels are important for supporting fish, invertebrates, and other aquatic life. Salmon and trout are particularly sensitive to reduced DO.

Dissolved oxygen in water depends not only on the saturation concentration but also on the oxygen losses (sinks) and sources. The primary sinks are respiration and the biochemical oxygen demand (BOD) of substances in water. Major sources of DO include photosynthesis and dissolution of atmospheric oxygen in water as oxygen levels are depleted (reaeration). Higher temperatures increase the rate of BOD (MacDonald et al., 1991).

The capacity of water to hold oxygen in solution is inversely proportional to temperature. For example, higher stream temperatures result in lower DO. In general, most forest streams have cool temperatures, rapid aeration rates, and relatively low oxygen demands. As a result, stream water is normally close to or at saturation. Full saturation does not usually occur in slow, low-gradient streams where the rate of aeration is slow; sites where fresh organic debris (particularly fine debris) causes a large BOD; or in warm, eutrophic streams where high levels of photosynthesis and respiration cause diurnal fluctuations in DO (MacDonald et al., 1991).

There are no available dissolved oxygen data for the Project Area. The current DO water quality standards set by the NCRWQCB (1996) are listed below for the beneficial uses of the waters in the Project Area. The water quality objectives state the DO levels shall not be reduced below the following minimum levels at any time:

- 6.0 mg/l for water that supports cold-water ecosystems including but not limited to preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates
- 7.0 mg/l for water that supports high-quality aquatic habitats suitable for reproduction and early fish development, primarily salmon and trout
- 9.0 mg/l for waters critical to salmon and trout spawning and egg incubation periods

More specifically, the NCWRQCB has prescribed minimum DO levels of 7.0 mg/l in the Eel River HU. No other watersheds in the Project Area have special DO prescriptions.

NUTRIENTS—NITROGEN AND PHOSPHORUS

Nitrogen and phosphorus are two nutrients that stimulate plant growth such as primary production and possibly secondary production. The nitrogen-to-phosphorus ratio or balance in solution in the water column determines the primary productivity of water bodies (WDNR, 1997).

Forest streams in the region commonly have very low background concentrations of nitrogen compounds, often lower than 0.01 mg/l (MacDonald et al., 1991). Nitrogen export to the aquatic system varies greatly during the year, reaching annual maximums in autumn with leaf fall (WDNR, 1997). Nitrogen fixing plants such as alder can increase levels of dissolved nitrogen (nitrate) in-stream runoff (Binkley and Brown, 1993). Nitrate is the predominant form in unpolluted water, and ammonia may exist as an intermediate breakdown product of organic nitrogen, fertilizers, and animal wastes. Both ammonium and nitrate are readily taken up by aquatic biota, so an increase in nitrate concentrations upstream tends to diminish rapidly downstream. The primary concern with nitrates is that increased biological activity due to increased concentrations of nitrogen can deplete dissolved oxygen, which may affect fish and other aquatic organisms (MacDonald et al., 1991). A study by Dahlgren (1998) on the effects of clearcuts on nitrate concentration in stream water in the Caspar Creek watershed indicated that stream-water nitrate concentrations were increased after clear-cutting, especially during high-discharge storm events. However, the elevated nitrate concentrations were substantially reduced downstream, and they returned to background levels downstream of the experimental watershed. The NCRWQCB Basin Plan (1996) water quality standard for nitrates (NO^3) is a 45-mg/l maximum concentration limit for domestic and municipal water supplies.

Phosphorus is tightly conserved within forest ecosystems (Salminen and Beschta, 1991). Studies in forested watersheds indicate phosphorus tends to be adsorbed to and carried by fine sediment due to the high proportion of surface area to volume of smaller grain sizes (Meyer, 1979; Holton et al., 1988). The adsorbed phosphorus on the fine sediment is contained within the mineral lattice of the sediment and is therefore unavailable for dissolution or biological uptake. The net effect of phosphorus adsorption by stream sediments is to convert dissolved phosphorus to fine particulate phosphorus which is suspended during periods of high, turbulent flows, primarily during the winter months; the dependence upon high turbidity and suspended sediment reduces the effect of summertime phosphorus concentrations (WDNR, 1997). However, the dynamics of phosphorus and sediment in stream systems of western coastal forests have received little attention (Salminen and Beschta, 1991). There is no information available concerning nutrients within the Project Area.

HERBICIDES

Herbicides have been used for industrial forestry for years in this area, starting in the 1960s. According to the HCP/SYP, herbicides are currently applied using ground-based methods. Herbicides are used wherever "intensive management" will take place on PALCO lands. Ground-based herbicide application does not occur within 25 feet of Class III streams or within Class I and II Stream watershed and lake protection zones (WLPZs). Herbicides that could be used include Oust?, Atrazine?, Roundup?, Accord?, and Garlon-4?. In the future, other chemicals may be used as well. Herbicides are discussed in detail in Section 3.14.

No herbicides were detected in groundwater samples from community wells in Hydesville, California (located in the lower Yager Basin), in August 1997. There has been no testing for potential pesticide adjuvents or spreaders, such as diesel. PALCO is the primary timber company in the Yager Creek watershed upstream of this water source to use forest herbicides (NCRWQCB, 1998).

FECAL COLIFORM

Fecal coliform is a group of bacteria commonly used for water quality monitoring. Fecal coliform bacteria are present in the gut and feces of warm-blooded animals (MacDonald et al., 1991). Fecal coliform and total coliform bacteria are associated with causing gastro-intestinal illness in humans. In forested areas, high levels of coliform bacteria are associated with inadequate waste disposal by recreational users, the presence of livestock or other animals in the stream channel or riparian zone, and poorly maintained septic systems (MacDonald et al., 1991). Recent sampling (March-April 1998) for fecal coliform in residential areas downstream of PALCO ownership in Freshwater Creek and Elk River shows levels between 10/100 ml and 1,750/100 ml for Freshwater Creek and 0/100 ml and 1,475/100 ml for the Elk River (http://137.150.176.38/ bacterio.htm).

3.4.1.4 Floodplains/Channel Morphology

Floodplains in the Project Area are located in the lowermost reaches of the major rivers. These include floodplains on the following rivers: Eel River (which is the largest); Van Duzen River (for most of its length in PALCO lands and downstream to its confluence with the Eel); Yager Creek near Carlotta; Mattole River; Bear River; Salmon Creek; Elk River; Freshwater Creek; Larabee Creek; and Jacoby Creek. Many of these rivers have experienced aggradation during the last 40 years (Kelsey, 1987). Much of the aggradation occurred during the 1964 flood. Although some recovery has taken place, continued high sediment output and the magnitude of the initial aggradation has left most of these floodplains in an unstable state (Kelsey, 1987). Aggradation can broaden the floodplain and reduce channel capacity, which spreads water out across the land during floods. Very wide channel migration zones are typical of most of these streams. Topographic and geologic maps indicate that most of the extensive floodplains are located downstream from PALCO lands. In addition, the Eel River (and its floodplain) may be migrating northward due to tectonic uplift of the area (Natural Resources Conservation Service [NRCS], 1995).

3.4.2 Watershed Impact Mechanisms

This section discusses the mechanisms by which timber harvest and associated activities can affect streamflow, water quality, and channel morphology. Section 3.4.2.1 discusses water quantity impact mechanisms that affect peak flows and low flows. Section 3.4.2.2 discusses impact mechanisms related to the water quality parameters of temperature, suspended sediment, turbidity, nitrates, and pesticides and herbicides. Section 3.4.2.3 discusses impact mechanisms related to channel morphology and related factors such as LWD and gravel mining.

Timber harvest may affect watershed characteristics in several ways. Water quantity may be affected by alterations in peak flows during storm events and possibly during low flows in the summer; these effects may in turn affect channel morphology. For a review of hydrological effects of timber harvest activities see Beschta et al. (1995), Spence et al. (1996), Meehan (1991), and Ziemer (1998).

3.4.2.1 Water Quantity Impact Mechanisms

Peak Flows

Timber harvest and road building can increase peak flows (flood levels) of streams in several ways: alteration of snowmelt patterns, interception of subsurface flows by the road network, and alteration of evapotranspiration patterns. The processes are described below.

Timber harvest can influence stream flow by increases in the amount of snowmelt (Beschta et al., 1995). Loss of vegetation decreases the snow interception and evapotranspiration properties of the forest, thereby increasing snow accumulation in logged areas (Bosch and Hewlett, 1982). Melting of snow accumulated in logged areas during rainstorms is often referred to as a "rain-on-snow" event. The resulting increase in water yields can be expressed in either increased summer base flows or increased (winter) peak flows (Hetherington, 1987; Bosch and Hewlett, 1982; Harr et al., 1979). How a watershed responds to rain-on-snow events depends on how much of the watershed is harvested and how much of the watershed falls within the elevations at which rain-on-snow events are most frequent (the "rain-on-snow zone"). The rain-on-snow zone varies according to geographic location. The timing and amount of harvest are important because more accumulation of snow is possible in areas with more open canopy, increasing the susceptibility of a watershed to rain-on-snow floods (Coffin and Harr, 1992; Rothacher, 1993).

North of the Project Area, during the largest floods recorded on Redwood Creek, rain-on-snow influences played a role (Harden, 1995). Harden (1995) compared the 1890 flood (pre-logging) to the 1964 flood (after heavy logging) and found that the quantity of rainfall was similar and each was a rain-on-snow event, but that the amount of runoff was much greater in the 1964 event. Additionally, the 1964 floods on the Eel and Van Duzen are thought to have been rain-on-snow events (Kelsey et al., 1995).

A rough estimate of the "hydrologically immature" areas of PALCO lands was made by calculating the area occupied by "open" and "young" forest. Hydrologically immature forests are those where the canopy closure is less than seven percent or where greater than 75 percent hardwoods or shrubs are present (WDNR, 1993). The areas of "young" and "open" forests (as defined in the SYP) were assumed to be equivalent to hydrologically immature forests. Rain-on-snow flooding has not been extensively studied in coastal California; the evaluated limits of the rain-on-snow zone had to be estimated based on studies in Washington State. The lower limit of the rain-on-snow zone was assumed to be a conservative 2,000 feet in the Project Area, which is slightly higher than the 1,500-foot limit assumed in Washington State (WDNR, 1993). This is a minimum elevation for rain-on-snow; the actual rain-on-snow elevation is probably higher. The upper limit of the rain-on-snow zone is assumed to be above the highest point in the Project Area (3,800 feet). Only about 5,800 acres of hydrologically immature areas above 2,000 feet is present, and these areas are distributed among the various watersheds. Given this relatively small area, it is unlikely that PALCO lands are affected by increased peak flows due to hydrologically immature forests. The total of all areas above 2,000 feet is approximately 18,000 acres, which indicates that even under the extreme case of all these lands being harvested at once, the risk of increased peak flows would be minimal.

Increases in peak flow can also occur as a result of road building, though these effects are usually only evident in smaller basins (Ziemer and Lisle, 1997). Roads intercept groundwater in road cuts, surface flow from small drainages, and direct rainfall (Best et al., 1995; Megahan, 1975). Roads can gather and transmit rainfall faster than the natural landscape, altering basin hydrology (Harr et al., 1975; Harr et al., 1979; Jones and Grant, 1996). Roads can act as an extension of the drainage network. In a study in western Oregon, roads caused the stream density to increase 38 percent over the preroad conditions (Wemple, 1994). Results of studies are mixed, however. In some cases, the effect of road building cannot be differentiated from the effects of timber harvest, since they often occur simultaneously or in quick succession. In other cases, where timber harvest was effectively factored out, there was no significant effect (Wright et al., 1990; Ziemer, 1981). Road location within the watershed studied may be a factor; if roads are closer to the mainstem, their contribution to hastening subsurface flow concentration would be small. On the other hand, Jones and Grant (1996) showed a significant increase in peak flows after road building. Harr et al. (1975) also showed an increase in peak flows related to roads.

Peak flows can also be affected by timber harvest alone through changes in evapotranspiration. Clearcutting, shelterwood cutting, and thinning eliminates or reduces a significant amount of surface area provided by needles and stems that would otherwise intercept precipitation and allow it to be evaporated when sufficient energy is available (Chamberlin, 1991) . In addition, fewer tree roots reduce the amount of water that would otherwise be extracted from the soil and hence be unavailable for streamflow. Soil water content and runoff can thus be higher in logged than in unlogged areas. Water yield has been shown to increase in harvested areas in the Pacific Northwest (Harr et al., 1979). The effect on peak flows, when damage to stream habitat can occur, is less clear. Mahacek-King and Shelton (1987) showed that peak flows from moderate-sized storms are somewhat augmented from increased runoff due to tractor logging in Redwood National Park (although road building may also have played a role in their study). In contrast, Ziemer et al. (1996) showed that only small peaks were significantly increased on Caspar Creek in Mendocino County. In their study, there were no observed effects of logging on large peak flows, while modest increases in relatively small storms at the beginning of the rainy season were demonstrated. Increases in flows from early fall storms, which tend to have less total rainfall than winter storms, are typically not “channel forming” flows (Ziemer 1996); therefore, scour and lateral erosion from peak flows are unlikely to be significantly greater after timber harvest. Other studies have documented the same effect (Mount, 1995).

The effects of timber harvest and road building on peak flows tend to be more noticeable in small basins than in large basins, because a large percentage of a small basin may be affected at one time. In addition, large basins respond differently to hydrologic effects than small basins. Stormflow response in smaller watersheds is determined more by hillslope parameters (which can be affected by timber harvest) than by channel network parameters (Robinson et al., 1995). The reverse is true for larger watersheds. The effect of road building on the extension of the drainage network decreases as watershed size increases, and increases to peak flows in small watersheds becomes alternated and desynchronized as they move downstream (Beven and Wood, 1993). On a large watershed such as the Eel River, synchronicity of peak flows from tributaries determines whether or not a measurable increase in peak flows occurs on the mainstem (Ziemer and Lisle, 1997). At this scale, channel network hydrology, which is less influenced by timber harvest activities, is more likely to affect the timing of increased peak flows (Ziemer and Lisle, 1997). There is limited evidence that large basins may be affected by timber harvest. In basins up to 230 mi^2, Jones and Grant (1996) observed increased peak flows among small storms (one-year recurrence interval) but speculated that runoff from larger storms would be affected as well. This was later questioned in a paper by Beschta et al. (1997).

Though the effects are usually minor, recovery of peak flows from hydrologic changes in a forest tends to be gradual. In western Oregon, Grant (1994) observed little peak flow recovery after 30 years. In another study, 50 percent hydrologic recovery was achieved in 25 years (Harr et al., 1989).

Low Flows

In the Project Area, summer is the period of low flows. Most of the studies concerning effects of timber harvest on hydrology have been conducted in areas with a similar hydrologic regime, but results have been highly variable. Most studies have demonstrated that timber harvest increases summer low flows somewhat. Hetherington (1987) documented a 78 percent increase in summer low flows from a 1,200-hectare watershed on Vancouver Island. Harr and Krygier (1972) noted average increases of 60 percent in low flows following clearcutting in coastal Oregon. South of the Project Area, in Caspar Creek, Keppeler and Ziemer (1990) documented increases in summer low flow that lasted five years. More recently, Ziemer et al. (1996) found several instances in the same watershed where summer low flows increased following harvesting. The proposed mechanism for increased base flow in the summer has been the increase in available groundwater. Water that would otherwise be taken up by trees and lost through evapotranspiration remains in the soil and contributes to base flow (Keppeler and Ziemer, 1990). Such an increase could be beneficial to aquatic organisms. In each study, flows returned to pre-logging levels within a few years.

Some studies have documented decreased summer low flows due to timber harvest. Hicks et al. (1991) showed a low-flow decrease that was not detectable until eight years after logging. The decrease was attributed to increase in growth of red alder along the clearcut streams. Harr (1982) showed that logging decreased summer flows in a coastal forest with significant amounts of fog-drip precipitation in the summer. Hardwood invasion of the riparian zone has been a persistent problem in drier parts of the area. Additionally, although fog-drip precipitation has been shown to be a significant source of precipitation in redwood forests (Dawson, 1996), most of this water appears to be used by shrubs and trees (Dawson, 1996). One recent study concluded that the loss of fog interception is compensated by the loss of evapotranspiration (Ziemer, 1998); more water is saved by decreased evapotranspiration than is lost by lack of fog interception. This is likely to be the case, and the potential effect of timber harvest on low flows would be a short-lived increase in the Project Area.

3.4.2.2 Water Quality Impact Mechanisms

The following sections build upon the information presented in the affected environment sections, showing the mechanisms by which water quality parameters are affected.

Temperature

Temperature plays an integral role in the biological productivity of streams. Aquatic life is the beneficial use of the water that is most sensitive to water temperatures. Salmonids and some amphibians appear to be the most sensitive to water temperatures. Thus, they are used as indicator species regarding water temperature and water quality. Coldwater species such as salmonids are susceptible to harm when stream temperature is greater than 70°F (Oregon Department of Environmental Quality [DEQ], 1995) (see Section 3.8). Juvenile salmon and trout are susceptible when the stream temperature is above 73 to 77°F.

Stream water temperature is regulated by heat exchange between the stream water and the aerial and subsurface conditions. Heat energy is transferred to and from streams by direct solar radiation (short wave), long-wave radiation, convective mixing with air, evaporation, conduction with the stream bed, and advective mixing with inflow from groundwater or tributary streams (Beschta et al., 1987; Sullivan et al., 1990). Direct solar radiation is typically the dominant source of energy input to streams. Long-wave radiation loss is determined primarily by the temperature differential between water and air, with the greater exchange occurring when the difference between the air and water temperatures is greatest (Spence et al., 1996). Convective and evaporative heat transfer are controlled by temperature and vapor pressure gradients at the air-water interface (Beschta et al., 1987). Conductive heat transfer between stream substrate and water generally represents a minor component of a stream heat budget (Spence et al., 1996).

The role of advection depends upon the volume of groundwater or tributary inputs relative to the total stream discharge. As groundwater flows toward stream beds, water temperatures equilibrate with those in the subsurface soil layers (Beschta et al., 1987). As a result, the temperature of water that enters streams from groundwater flow depends upon the ambient conditions in the soil environment. Seasonal fluctuations are greatest at the soil surface and decrease with depth to the "neutral zone," generally about 16 to 18 meters below the surface where temperatures remain constant throughout the year (Meisner, 1990). In warmer environments, groundwater seeps in streams may actually reduce streamwater temperatures in localized areas.

All of the above processes interact to produce the temperature regimes observed in streams and rivers. In small- to intermediate-size streams of forested regions, incoming solar radiation represents the dominant form of energy input to streams during the summer, with convection, conduction, evaporation, and advection playing relatively minor roles (Brown, 1980; Beschta et al., 1987; Sullivan et al., 1990). Groundwater discharge to streams may be important to small streams where groundwater discharge provides a large percentage of the overall discharge, particularly in the summer months during low flows. Downstream where the stream is larger, the effects of riparian shading and advective mixing diminish and evaporative heat-loss processes increase.

Microclimate is discussed in more detail in Section 3.7.

A major water temperature concern in managed forest ecosystems is summer stream temperature increases associated with timber harvesting near streams. The principal source of energy that heats small streams is incoming solar radiation that strikes the water surface and becomes stored in the water. The more canopy removed, the greater the exposure to solar radiation, which then increases stream temperature.

Both stream width and air temperature are additional factors that influence stream temperature (Sullivan et al., 1990). Stream width is also a contributing factor to stream temperature because it affects potential shading from streamside vegetation. Narrow streams can easily be shaded by relatively short vegetation, while wider streams will remain more open, even under mature forest vegetation.

Stream wetted widths and bankfull widths increase with distance from the watershed divide. As the wetted channel width increases, the amount of hemispherical view above the channel that is open to the sky (view factor) increases. As river channels become wider, the influence of riparian shading on water temperature becomes negligible (Sullivan et al., 1990). Therefore, in the PALCO lands, where channel width becomes greater, such as for parts of the Eel River, Van Duzen River, and lower Yager Creek, the effectiveness of buffers becomes negligible in terms of stream temperature.

In western Oregon, Beschta et al. (1987) concluded that a 100-foot buffer width in second growth can provide the same level of shading as an old-growth system. The relative degree of shading provided by a buffer strip depends on species composition, age of stand, and density of vegetation. Although buffer strip width is important, by itself it is not a good predictor of shade protection. Different riparian forest stands will take different amounts of time to reach an equivalent angular canopy density (ACD) as an old-growth system. ACD is the projection of the canopy measured at an angle above the horizon at which direct-beam solar radiation passes through the canopy. The angle is determined by the position of the sun above the horizon during the time of day when solar heating of the stream is highest. Young riparian redwood and Douglas-fir forests will reach an ACD equivalent to old growth within 10 to 12 years after clearcutting depending on stand composition and other environmental conditions (Beschta et al., 1987; Beschta, 1990).

The buffer widths or RMZs as defined in the alternatives of this EIS/EIR would be fundamental in maintaining or improving stream temperatures. Several HUs contain Class I streams flowing through open areas and young forest that provide little canopy or shade to the stream. Open areas include “open natural,” “grasslands,” and “forest openings” as defined in Section 3.9 and presented in Figure 3.8-2. Streams that flow through the “forest openings” and “young forest” vegetation designations are likely to have different vegetation types such as mid-seral vegetation that remained as part of the harvest prescriptions in Class I and Class II WLPZs per current FPRs, but were not within the resolution of the GIS data layer. However, the greatest percentage of streams that flow through open areas tend to flow through “open natural” areas (Figure 3.8-2a and 3.8-2b).

HUs with Class I streams flowing through open areas on PALCO lands include Bear River (32 percent open area), Larabee Creek (31 percent open area), Lower Yager (57 percent open area), North Yager (42 percent open area), Sequoia (35 percent open area), Upper North Fork Mattole

(48 percent open area), North Fork Mattole River (39 percent open area) and the Van Duzen WAA (29 percent open area) (Figure 3.8-2). HUs with Class I streams flowing through areas of over 20 percent young forest include Lawrence Creek (29 percent) and Middle Yager (37 percent). Warm stream temperatures associated with these watersheds may improve (i.e., temperature declines) with open area riparian regeneration over time.

Class II streams flowing through open areas greater than 10 percent include Bear River (10 percent), North Fork Mattole River (10 percent), and the Upper North Fork Mattole (10 percent). Class II streams that flow through areas of over 20 percent young forest include the Avenue of the Giants (23 percent), Lawrence Creek (41 percent), Sequoia (25 percent), Lower Yager (25 percent), North Yager (48 percent) and Middle Yager (39 percent) (Figure 3.8-2). With adequate buffer protection, the stream temperatures should improve over time along streams in these HUs as the young forests regenerate.

RMZs along Class I and II streams would have the most significant impact on temperature, as the riparian vegetation will provide the shade necessary to maintain stream temperatures for beneficial uses. Class III stream buffers would have little to no direct effect on water temperatures, as these intermittent streams tend to be dry during the critical summer months when high water temperatures are a concern.

Suspended Sediment

An increase in suspended sediment has numerous effects on the aquatic system. Physically, fine sediment can impair municipal and agricultural use of water, affect bed material size, and alter the quantity and quality of habitat for fish and benthic invertebrates. Fine suspended sediments can also affect the chemistry of the water as chemical nutrients and other chemicals are adsorbed onto fine particles.

Timber harvest activities such as road building and timber yarding may increase sediment input into streams. Although erosion rates in the Coast Ranges are high, management related activities (e.g., changes in land use patterns) have accelerated the naturally high rates in many areas (Anderson, 1979). The key factors controlling sediment increases are (1) the intensity of the disturbance, (2) the areal extent of the disturbance, (3) the proximity of disturbance to the channel system, (4) storm events experienced when the site is most sensitive to erosion and mass movements, and (5) BMPs used to control sediment delivery to streams (Everest et al., 1987; Swanson et al., 1987). Sediment can be eroded from road surfaces, road fills, or slope failures associated with road construction (e.g., blocked culverts). Increased sediment yields tend to be persistent from slope failures and road surface runoff. Timber harvest often results in surface erosion from landings, skid trails, and other compacted areas (Binkley and Brown, 1993; MacDonald et al., 1991; Moring, 1982). Ziemer et al. (1996) note a 400 percent increase in suspended sediment following road building, and a 100 to 500 percent increase after logging commenced for timber harvest in the early 1970s in the Caspar Creek watershed near Fort Bragg, California. They noted much smaller effects for logging that occurred from 1985 to 1991 because of improvements in BMPs (Ziemer et al., 1996). Section 3.6, Soils and Geomorphology, discusses these effects in detail.

Implementation of improved FPRs over the last 20 years is considered to have significantly decreased sediment input to streams relative to past practices (Cafferata and Spittler, 1998; Lewis, 1998;

CDF, 1987; Binkley and Brown, 1993; CDF, 1995).

Fire can also be a source of increased sediment yield, primarily through increased surface erosion, which is caused by a decrease in protective vegetation and an increase in surface runoff (see Section 3.6).

Turbidity

Timber harvest effects on turbidity closely correspond to the effects on suspended sediment (Barber, 1997; Brown and Ritter, 1971). The same dominant processes that increase suspended sediment will increase turbidity: landslides, surface erosion, and road erosion (see Section 3.6).

Biological effects of increased turbidity may include a decrease in primary productivity of algae and periphyton due to the decrease in light penetration (see Section 3.8). Declines in primary productivity can adversely affect the productivity of higher trophic levels such as macroinvertebrates and fish (Gregory et al., 1987).

Siltation and turbidity reduce the diversity of aquatic insects and other aquatic invertebrates by reducing interstices in the substrate. Several studies (Nuttall and Bielby, 1973; Bjornn et al., 1974; Cederholm et al., 1978) have demonstrated that species density and diversity drop with increased fine sediment deposition in gravels.

Siltation and turbidity have also been shown to affect fish adversely at every stage in their life cycle (Iwamoto et al., 1978); spawning and incubation habitats are most directly affected (Spence et al., 1996). Deposited sediments tend to have a greater impact on fish than suspended sediment. Particulate materials physically abrade and mechanically disrupt respiratory structures (e.g., gills in fish) (Rand and Petrocelli, 1985). Sediment covers and fill intergravel crevices, which fish use for shelter, decrease the carrying capacity of stream habitats for young salmonids (Bjornn et al., 1974). Turbidity reduces light penetration, which affects the food capture reactive distance of juvenile and adult salmonids (Spence et al., 1996).

Dissolved Oxygen

Most forest streams have low vulnerability to low DO because fine organic matter is generally minimal, and reaeration of flowing water is more than sufficient to maintain high levels of DO. Current forest practices are not believed to input enough slash to cause management-induced depletion of DO through an increase in BOD, except where DO is naturally low (Skaugset and Ice, 1989). Adverse depletion of DO, however, may occur when the following conditions are present (MacDonald et al., 1991, Ice, 1992; Ice, 1991):

- Very slow-moving, low-gradient, warm streams with low discharge (i.e., low aeration rates), including impounded wetlands, especially those formed by beaver
- Heavy inputs of fine organic debris to low-flow streams causing a large BOD, or naturally high concentrations of organics

Nutrients

Forest management activities can affect several different parts of the nitrogen cycle, making generalizations regarding effects of land management activities difficult. The low nitrogen-to- phosphorous ratio in most forest streams, however, suggests that changes in phosphorous loading with sedimentation are unlikely to have adverse effects on the aquatic system. One trend that has been observed is that logging, fire, and forest fertilization can increase nitrogen concentrations in streams.

Timber harvest, burning, and grazing may cause an increase in stream nutrients.

Harvest of forests has been shown to increase nitrate levels as much as three to five times for up to three to five years (Fredricksen et al., 1975; Sollins and McCorison, 1981), although severe burning has resulted in changes 10 times higher. Soil erosion and input of organic matter are the primary mechanisms for increasing phosphorous levels in aquatic systems. Systematic scientific reviews, however, have concluded that forest practices in the wetter forests in this region are unlikely to substantially increase phosphate concentrations in aquatic systems (MacDonald et al., 1991; Salminen and Beschta, 1991; Wolf, 1992).

On PALCO lands, broadcast burning following intensive management is a common silvicultural practice, but is not used in WLPZs. However, burns that begin outside of a WLPZ may inadvertently burn the WLPZ. In addition, fertilizer is not currently used on PALCO lands, but could be used in the future. However, limitations include no aerial applications, and ground applications in RMZs along Class I and Class II streams for erosion control only.

Pesticides and Herbicides

The main potential of herbicides to influence water quality is the tendency for the chemicals to adsorb to soil particles and then to be transported by subsequent soil erosion. The transport of the chemicals from the terrestrial environment to the aquatic environment occurs during high precipitation and runoff events. Intermittent application of low concentrations of herbicides has small or insignificant effects on aquatic organisms (MacDonald et al., 1991). Another concern with the application of herbicides is the effect on riparian vegetation. Herbicides may kill riparian vegetation and initiate a series of adverse effects on aquatic organisms and the stream channel. Atrazine is considered a “detected leacher” under the California Pesticide Contamination and Prevention Act of 1985: Groundwater Protection List. It has the potential to pollute based upon detection in groundwater under certain conditions (NCRWQCB, 1998). According to the HCP/SYP, there would be no application of herbicides along Class I and Class II streams. However, herbicide application may occur along Class III streams.

The NCRWQCB has regulations regarding the maximum concentration limits of certain pesticides in waterbodies. The NCRWQCB has determined that the implementation of BMPs by private forest landowners has not violated the pesticide and herbicide water quality objectives stated in the Basin Plan. Ground-based application reduces the risk of direct contamination of streams, provided that proper care is taken in the transport, mixing, application, and disposal of the herbicides, especially in riparian areas. The BMPs followed by many timber companies in Humboldt County meet or exceed the BMPs prescribed by the County Agricultural Commissioners for the aerial application of herbicides (NCRWQCB, 1998). In the past 14 years, the NCRWQCB has required monitoring of the aerial application of herbicides and has found that 95 percent of the collected surface water samples contain less than two parts per billion (ppb) and 99.5 percent of collected water samples contain less than 10 ppb of herbicides. Ground applications of herbicides should pose less risk than the aerial application of herbicides (NCRWQCB, 1998). Herbicides are discussed in detail in Section 3.14.

Fecal Coliform

Livestock grazing may impair water quality and its beneficial uses by adding inorganic and organic sediments and bacterial contaminants (fecal coliform) to the water and by physically altering riparian and instream habitat. All of these effects can severely degrade water quality by creating unsafe drinking water for humans and poor water quality for aquatic biota.

The NCRWQCB has not found impacts of grazing to be a priority water quality problem (Personal communication, Frank Reichmuth, NCRWQCB, 1997). However, Kelsey (1980) found that grazing of prairie uplands contributes substantial amounts of sediment to streams in the Van Duzen watershed. It is likely that grazing contributes some sediment to streams in the other watersheds (Bear, North Fork Mattole, Lower Eel, Larabee, and Lawrence), but the proportion relative to other practices and natural erosion remains unknown.

3.4.2.3 Channel Morphology and Floodplain Impact Mechanisms

The hydrologic regime of a watershed, in combination with its geology (which influences the channel and determines sediment supply), determines the nature of stream channel morphology (e.g., number and spacing of pools and width-to-depth ratio) (Beschta et al., 1995). Consequently, changes to the hydrologic regime can affect channel morphology. The relationships among water input, sediment input, and channel form are well-studied but complex (see Figure 3.4-4). Channel morphology can be affected indirectly by land use practices, or directly by in-stream activities (Beschta et al., 1995). In the Project Area, the primary indirect effects are caused by increases in sediment flux, decreases in streambank stability, and loss of potential LWD, while direct effects are potentially caused by gravel bar scalping (gravel mining) and direct removal of LWD.

Sediment Flux

Timber-harvest-related effects from erosion and mass-wasting increased sediment yield may exceed a river's ability to carry its sediment load, resulting in sediment storage along and in the channel (see Section 3.6). This typically results in decreased pool depth, higher width-to-depth ratio, decreased number of pools, and an increase in fine sediment in riffle sections of streams (Madej, 1982). The persistence of stored sediment within a stream reach affects local hydraulics and habitat (see Section 3.8). Additionally, aggradation limits the degree to which LWD pieces can be anchored.

Ozaki and Madej (1996) documented a large influx of sediment in Redwood Creek associated with timber harvest conducted before the mid-1970s. This influx produced a persistent sediment wave which migrated downstream. The sediment wave was initiated by the extreme storm events of 1955, 1964, 1972, and 1975, and aggraded as much as 30 feet at some sites. The channel in the upper portion of Redwood Creek showed an abrupt response and a distinct recovery (return to pre-flood morphology). Recovery was less distinct in the lower reaches. The sediment wave generated in the upper watershed became attenuated downstream. Peak sedimentation rates lagged 18 years or more behind upstream sites. In addition, the rate of movement downstream of the sediment wave decreased from 1,700 meters per year to 700 meters per year. Ozaki and Madej (1996) concluded that while Redwood Creek is beginning to show signs of recovery from the series of large storms in the 1960s and 1970s, it is still susceptible to channel changes above those attributable to natural factors due to channel widening and undermining of streambanks. Because Redwood Creek has similar climate, vegetation, and geology, the conclusions from this study are broadly applicable to the Project Area, indicating susceptibility to extreme storm events.

Project Area channel segments that are located in relatively the same position in the watershed as in the Ozaki and Madej

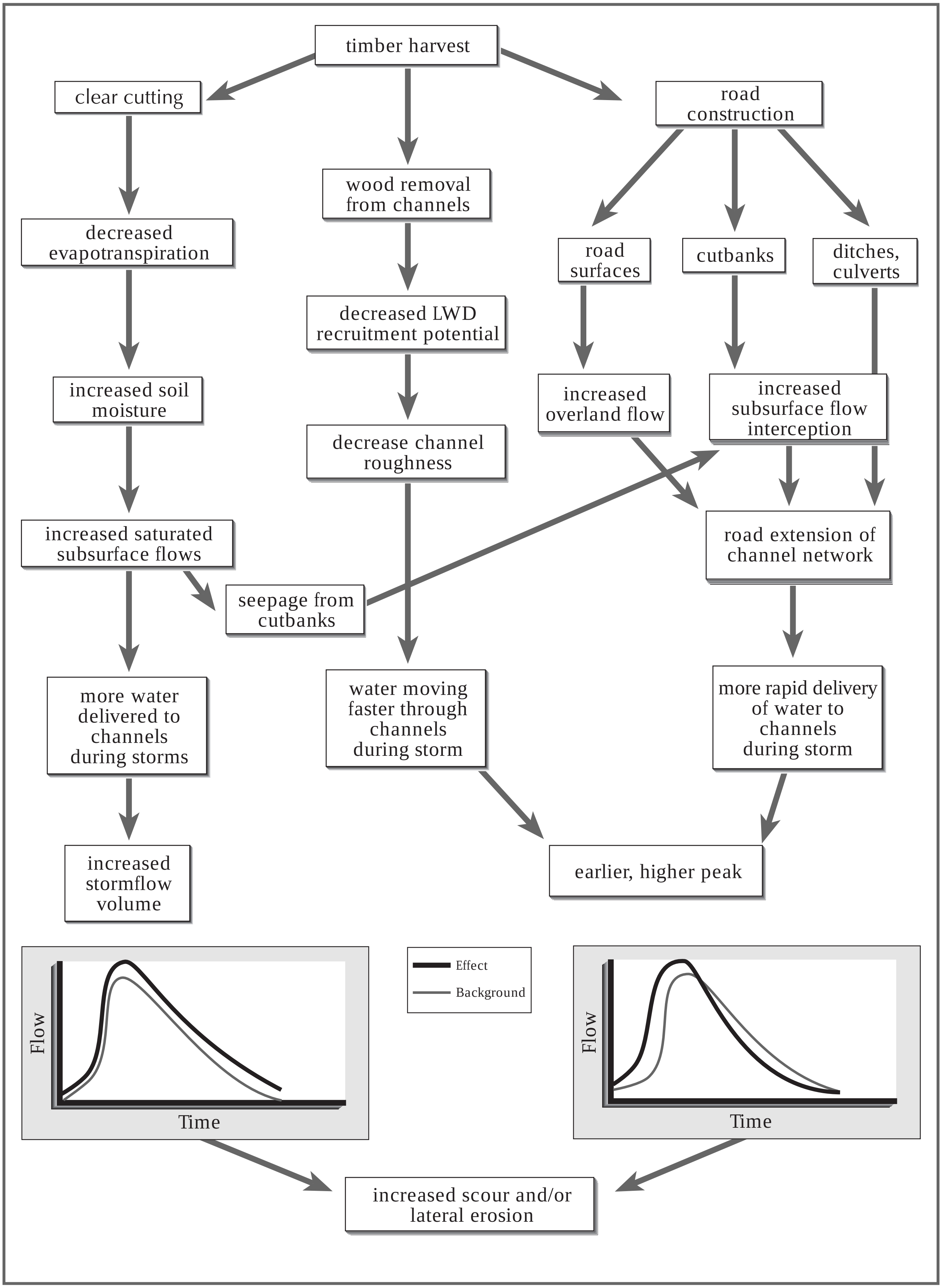


Figure 3.4-4. Relationship Among Timber Harvest, Road Building Peak Flows, and Channel Erosion

(1996) study could have similar vulnerability. This would include channel segments in the lower reaches of each watershed. Lisle (1986) indicates that this is the case on the Eel River. In this watershed, channels have incised into flood deposits, leaving a narrower channel bounded by vegetation. However, many of the tributaries which are bound on one bank by bedrock or colluvium have remained wide. Because floodplain storage has been severely reduced, the flood water depth during a storm event of a given recurrence interval is likely greater than under pre-logging conditions and prior to the extreme storm events before 1975. This in turn may perpetuate wide channels, but has not been documented. On the Van Duzen River after the 1964 flood, the length of channel affected by debris avalanches increased by 423 percent in the upper watershed (mostly on non-PALCO lands), and by 119 percent in the lower watershed (mostly PALCO lands) (Kelsey, 1980).

Streambank Stability

In addition to sediment influx, channel morphology can be modified by decreased streambank stability. Timber harvest can decrease streambank stability through loss of root strength (Beschta et al., 1995). Tree roots also provide cohesion to slopes (see Section 3.6). However, redwoods often resprout when cut, thereby retaining some amount of root strength.

Meandering streams incised into alluvium usually exhibit a down-valley migration of meanders over time. If root strength is diminished in the floodplain in which meanders are migrating, acceleration of bank erosion could occur (Beschta et al., 1995). However, compared to other controls on meander migration such as peak flows and sediment inputs (Sullivan et al., 1987), and the fact that such migration occurs over many decades, the loss of root strength probably would not play a significant role in the pattern or rate of meander migration.

Large Woody Debris

LWD plays a role in at least the short-term stability of a stream channel. Logs that have fallen into a stream become embedded and hold back, at least temporarily, sediments that are moving downstream. LWD is very important in providing diversity of habitat on a local scale (see Section 3.8). The effects of diminished inputs of LWD to a stream are incremental. A threshold for effects on channel morphology is not, and probably cannot, be defined. However, complete removal of LWD can result in a four-fold increase in bedload transport (Smith et al., 1993). In fact, the work of Smith et al. (1993) suggests that the entire channel structure can be rearranged in just one season when LWD is physically removed. Stored sediments and bank instability contribute to the increased bedload transport. Since LWD may influence channel stability, there is potential to affect channel migration. In a channel migration zone, e.g., a meander belt, if a floodplain terrace is harvested, loss of the LWD that would fall down from the banks into the stream may allow increased erosion of the banks. On a forested terrace, trees fall into the stream as the bank is undermined, and the trees deflect water from direct attack on the streambank. Without the deflection of the flows by LWD, an increase in the rate of lateral erosion may occur (Toews and Moore, 1982). It is for this reason, more so than loss of root strength, that timber harvest in the channel migration zone could have significant effects on the rate and form of channel migration. No research has been conducted on the effect of partial cutting on streambank stability. It is likely that the effects would be less than from clearcutting, but there may be thresholds, based on the interconnectedness of root wads, that would be important in streambank stability.

In forested lands, channel structure is in large part determined by the presence or absence of LWD. LWD anchored into the streambank or bed traps sediment and creates pools. A stepped pool channel profile often results from LWD. In this way, LWD reduces the channel gradient over short reaches. In general, LWD dissipates much stream energy. In addition, LWD supports numerous important stream functions critical to fish habitat (see Sections 3.7 and 3.8).

Physical removal of LWD directly affects stream morphology, since bed scour may occur, leading to lateral erosion (Nekamura and Swanson, 1993). In many forests across the Pacific Northwest and northern California, logs have been removed from the streams either by logging companies for timber, or by government agencies in the 1960s and 1970s, when it was thought that LWD removal would improve fish access (Mount, 1995). Loss of LWD has also occurred due to a lack of input related to the timber harvest that occurs within the zone of LWD contribution to the stream. The zone of LWD recruitment has been the subject of many studies (e.g., Swanson and Lienkaemper, 1978; Sedell et al., 1988; McDade et al., 1990). Various amounts of recruitment loss will occur depending on how many trees are cut within this zone. Over time, in-stream LWD decays so that loss of recruitment may have the same effect as removing LWD from streams. Grette (1985) showed that recovery of LWD recruitment did not begin to occur until 50 or 60 years after logging.

Current FPRs allow for a recruitment potential of only 23 percent of the full potential, if minimum standards are applied (Murphy, 1995). Historical logging operations are known to have included removal of LWD from streams often performed at state agency request (Mount, 1995). These factors indicate that LWD is limited on PALCO streams, but the extent to which channel morphology and/or floodplains have been affected is unknown. Field inventories of LWD have confirmed deficiencies in all WAAs (R2, 1997).

Construction in Floodplains

The parameters that could affect floodplains include the following:

- Construction or excavation and filling of the floodplain
- Constrictions in the stream channel, such as a bridge, which could change the floodplain locally
- Long-term sedimentation
- Susceptibility to major storm events with related aggradation

Effects on floodplains are also strongly correlated to channel morphology. Channel aggradation can increase flood frequency in the area adjacent to the affected stream reach. The primary effect on floodplains is change in its ability to absorb and transmit flood flows.

Gravel Mining

Excavation of sand and gravels from streams has direct effects on the fluvial system (Kondolf and Matthews, 1993). Removal of part of the streambed alters the hydraulic characteristics of the channel and interrupts the natural transport of bedload through the stream. The most immediate consequence can be degradation of the bed both upstream and downstream. Creation of a hole in the streambed makes the channel locally steeper and thereby increases the shear stress on the bed. Erosion of the bed will propagate upstream as additional sections become steeper and progressively erode (Collins and Dunne, 1989). This erosion can affect fish spawning gravels and can endanger structures in the river such as bridges or piers (Mount, 1995). If the bed degradation is rapid, streambanks can be undermined.

The initial pit also serves as a bedload trap and removes part of the stream's bedload. The flowing water would then have greater potential to erode the bed and banks downstream from the pit. Additionally, consistent removal of gravel from bars in a river limits and/or prevents any natural establishment of vegetation on the bars, and may lead to long-term changes in channel configuration at the local site. Gravel mining may also decrease flood levels by providing more room in the floodplain to accommodate flood flows.

Gravel mining by skimming, in which successive layers of gravel are incrementally removed from the surface of a gravel bar, as proposed by PALCO, is not expected to have the same effects as pit mining of gravel. Research on the effects of this method, however, is relatively sparse.

3.4.3 Environmental Effects

The following sections describe, by issue, the effects of each alternative on water quantity and quality, as well as on floodplains. In some sections, where sufficient data were available, effects are discussed by WAA or HU. Section 3.4.3.1 discusses effects on water quantity, including peak flows and summer low flows. Section 3.4.3.2 discusses effects on water quality, including water temperature, sediment, and turbidity. Section 3.4.3.3 discusses floodplains, channel morphology, and gravel mining. A summary of the effects by alternative is presented in Table 3.4-6.

3.4.3.1 Thresholds of Significance

The interrelationship of management activities, environmental components or systems, and related thresholds of significance, are discussed in Section 3.1 and illustrated in Figure 3.1-1. Section 3.1 describes the interrelationship of effects among the environmental components and the related thresholds of significance for Sections 3.4, Watersheds, Hydrology, and Floodplains, 3.6, Soils and Geomorphology, 3.7, Wetlands and Riparian Lands, and 3.8, Fish and Aquatic Habitat.

Each section below defines significance somewhat differently. The scientific understanding of the impact mechanisms and the availability of data determined the threshold. Specific thresholds of significance are discussed at the beginning of each subsection. For land management activities that affect large areas such as the proposed alternatives, effects are diffused across the landscape, and in many cases are not quantifiable without site-specific monitoring and study. Therefore, thresholds were generally defined in a qualitative manner, based on what was considered to be the most reasonable framework for evaluating effects. Thresholds of significance for water quality parameters are based on the NCRWQCB Basin Plan. However, the ability to meet these thresholds is based on an evaluation of the type and range of prescriptions and BMPs applied across the landscape.

3.4.3.2 Water Quantity Effects

Peak Flows

THRESHOLD OF SIGNIFICANCE

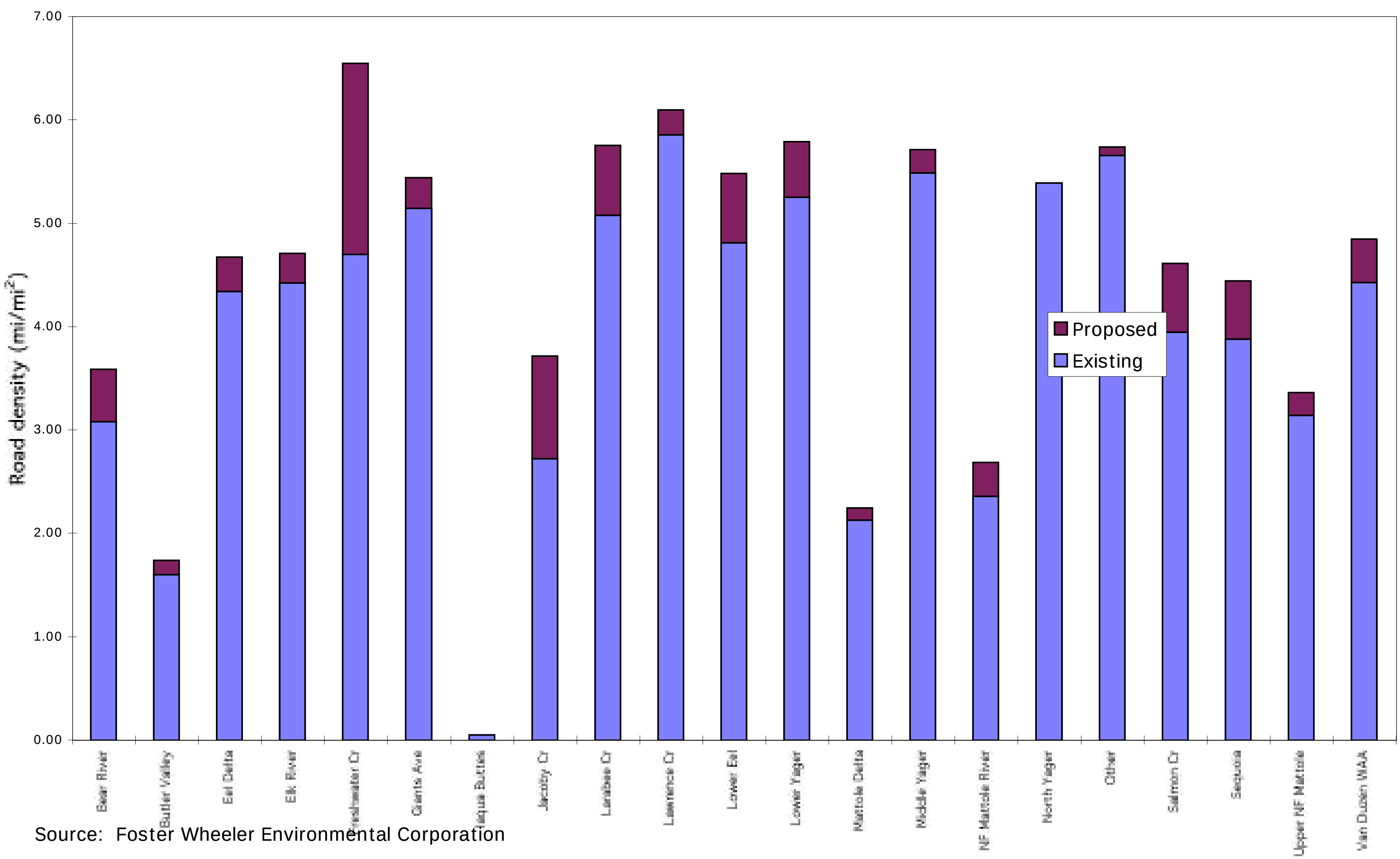
The effects of changes in stream flows are highly site-dependent. Potential effects of increased peak flows include the risk of stream channel changes and the risk of affecting people or property. To provide a frame of reference for evaluating significance, two quantitative standards were used. For the effects on stream channels, the likelihood of one foot of scour and/or bank erosion on an aggregate of 1,000 feet of Class I (perennial fish-bearing) and Class II (perennial nonfish-bearing) streams was used as a threshold. For risk to people and property, the likelihood of changing the recurrence interval of a storm from five years to two years was used for a threshold. These two thresholds serve as a standard for judging

Table 3.4-6. Relationships Between Management Activities and Water-Related Parameters

	Impact Parameter						
	Water Quantity			Water Quality			
Geomorphic Process/ Management Activity	Peak flows	Low flows	Floodplains/ Channel Morphology**	Turbidity/ Suspended Seds.*	Nitrates	Temperature	Herbicides
Timber harvest	Yes	Yes	Yes	Yes	No	Yes	Yes
Roads	Yes	No	Yes	Yes	No	No	No
Gravel mining	No	No	Yes	Yes	No	No	No
Site operations	No	No	No	Yes	No	Yes	No
Alternative 1							
Timber harvest	0	0	+	-	0	-	0
Roads	-	N/A	-	-	N/A	N/A	N/A
Gravel mining	N/A	N/A	0	0	N/A	N/A	N/A
Site operations	N/A	N/A	N/A	?	?	?	N/A
Overall effect	-	0	+	-	?	?	0
Alternatives 2 and 2a							
Timber harvest	0	0	+	+	0	+	0
Roads	0	N/A	+	++	N/A	N/A	N/A
Gravel mining	N/A	N/A	0	0	N/A	N/A	N/A
Site operations	N/A	N/A	N/A	?	?	?	N/A
Overall effect	0	0	+	+	?	?	0
Alternative 3							
Timber harvest	0	0	++	+	0	++	0
Roads	0	N/A	+	+	N/A	N/A	N/A
Gravel mining	N/A	N/A	0	0	N/A	N/A	N/A
Site operations	N/A	N/A	N/A	?	?	?	N/A
Overall effect	+	0	++	+	?	?	0
Alternative 4							
Timber harvest	0	0	++	++	0	++	0
Roads	0	N/A	+	++		N/A	N/A
Gravel mining	N/A	N/A	0	0	N/A	N/A	N/A
Site operations	N/A	N/A	N/A	?	?	?	N/A
Overall effect	0	0	+	+	?	?	0

0 = negligible trends
- = trend away from background
-- = rapid trend away from background

+ = trend toward background
++ = rapid trend toward background
? = variable, indeterminate
N/A = not applicable
Background = mature forest
*Keyed into fine sediment delivery; see Soils/Geomorphology section
**Keyed into coarse sediment as well as peak flows; see Soils/Geomorphology section
Source: Foster Wheeler Environmental Corporation



Source: Foster Wheeler Environmental Corporation

Figure 3.4-5. Road Density on Palco and Elk River Timber Company Lands and Proposed Road Density for First Decade of HCP

g:\1693\palco2\Figure 3.4-5 Chart 1

effects although only qualitative estimates of bed scour or flood recurrence intervals are made. Under each alternative, the potential for peak flow increases related to roads will be discussed first, followed by the potential for increased peak flows related to timber harvest.

ROAD-RELATED PEAK FLOW INCREASES - ALL ALTERNATIVES

Existing and proposed road densities are shown in Figure 3.4-5. The road density in each watershed is assumed not to vary significantly among the alternatives. Most PALCO land already has a relatively high road density; thus, PALCO would not have to build many new roads to access timber. Although approximately 400 miles of road are expected to be built during the life of the HCP, this would be only 25 percent of the total existing road mileage.

The location of roads and percent of a watershed occupied by roads are the likely factors to potentially increase peak flows. Roads located on ridge-tops are less likely to drain into and cross streams compared to roads located at mid-slope and lower-slope that cross and drain into many streams. Also, the road density of a watershed would more likely effect increases in peak flows at the zero- and first-order basin scale where a road would occupy a larger percentage of that zero- and first-order basin. Assuming a road width of 30 feet, a road density of 10 miles per square mile is equivalent to approximately 5.6 acres of road per acre of land or 5.6 percent of the watershed. In a zero- or first-order basin, if half the acres are impacted by roads, there would be a greater potential of peak flow increases.

Keppeler and Ziemer (1990) indicated that no effects occurred at Caspar Creek with 4.5 percent of a watershed occupied by roads (7.8 mi/mi^2). However, they also noted for the watershed they studied that the only road present was located adjacent to the mainstem, a situation in which drainage network extension from roads would be minimal. Jones and Grant (1996) found indications of peak flow increase in watersheds that were six percent roaded (10.5 mi/mi^2). Increased peak flows are most likely to occur where the road densities are the highest. The higher the road density, the more likely the effect on peak flows. The effects of increased peak flows are likely to be more pronounced in zero-, first- and second-order watersheds and in that order. While the level of increase in peak flows (and thus effects on channel morphology) cannot be predicted, streambanks in the area are generally sensitive to flood flows due to the highly unstable nature of the streambanks and hillslopes adjacent to streams (see Section 3.6, Soils and Geomorphology).

Currently, seven HUs have road densities which approach 6 mi/mi^2. If proposed roads are added to existing roads, nine HUs will be above 5 mi/ mi^2, while two will be above 6 mi/mi^2 in road density (Figure 3.4-5). The highest density of proposed roads occurs in the Freshwater Creek HU, where an additional 1.9 mi/mi^2 of road would be added. In the future, it would have a road density of approximately 6.5 mi/mi^2. The Lower Eel, Lower Yager, Lawrence Creek, North Yager, and Larabee HUs would also have relatively high road densities. Notably, the linkage between new roads and the stream system would not be as direct as with older roads with inside ditches. The Road Guidelines (discussed in Section 3.6, Soils and Geomorphology) recommend outsloping of roads with rolling dips where feasible, and installation of cross drains at regular intervals depending on road slope. Both of these practices would limit the extension of the drainage network that occurs from roadbuilding. Therefore there is some built-in mitigation for new roads' effects. If many roads are located in zero- or first-order basins, scour could occur on these smaller channels in zero-, first-, and second-order watersheds, which in turn could lead to slightly increased aggradation on mainstem channels (Personal communication, R.R. Ziemer, 1998).

Under each alternative, the creation of a Reserve would have little or no effect on road-related peak flows. Under Alternatives 2, 2a, and 3, the Reserve would not contain numerous roads, because it would be comprised mostly of old-growth forest. Some roads would be in the Reserve; however, no new roads would be built, and there would be virtually no change from current hydrologic conditions.

Under Alternative 4, there would be no modification of roads within the Reserve. Thus, significant amounts of roads would remain hydrologically linked with streams. While there would be no additional effect beyond current hydrological conditions, zero, first, and possibly second order watersheds with very high road densities could experience increased peak flows in the small stream channels.

No specific mitigation has been identified for increased peak flows due to roads under the alternatives. However, some incidental protection would be provided by such measures as using outsloping on new roads wherever possible, and appropriate spacing of ditch relief culverts. These measures would decrease the risk of and/or volume of increased peak flows. Although the unmitigated risk of peak flows would be moderate to high, with the above mitigation it would be reduced to a moderate level.

TIMBER-HARVEST-RELATED PEAK FLOW INCREASES

Alternative 1 (No Action/No Project)

The state and federal assumptions for assessing environmental impacts to aquatic resources under the No Action/No Project alternative differ due to differences in analysis approach required by CEQA and NEPA. CEQA implementing regulations require that an EIR discuss "the existing conditions, as well as what would be reasonably expected to occur in the foreseeable future if the project were not approved" [14 CCR 15126(d)(4)]. CEQA does not require either a projection into the long-term future that could be deemed to be speculative, nor does it require a quantitative analysis of the No Project alternative for comparison with the other alternatives. Accordingly, the state version of the No Action/No Project alternative analyzed here contemplates only the short term and is based on individual THPs that would be evaluated case by case. The CDF version of No Action/No Project alternative does not attempt to forecast how PALCO's entire property would look in 50 years (the length of the proposed ITP). Since it is unknown how many THPs there would be, where they would lie geographically, and how they would differ in detail, no quantitative analysis of THPs is presented (see Section 2.5).

The likely No Action/No Project alternative would consist of PALCO operating in a manner similar to current THP practices and subject to existing CDF regulatory authority. In reviewing individual THPs, CDF is required to comply with the FPA, FPRs, and CEQA through its certified functional equivalent program (see Section 1.6). The specific criteria for evaluating THPs contained in the FPRs are combined with the case-by-case evaluation of each THP for significant effects on the environment followed by consideration of alternatives and mitigation measures to substantially lessen those effects. Under CEQA and the FPRs, CDF must not approve a project including a THP as proposed if it would cause a significant effect on the environment and there is a feasible alternative or feasible mitigation measure available to avoid or mitigate the effect. An adverse effect on a listed threatened or endangered species would be a significant effect under CEQA.

In addition, the present FPRs provide that the Director of CDF shall disapprove a THP as not conforming to the rules if, among other things, the plan would result in either a taking or a finding of jeopardy of wildlife species listed as rare, threatened, or endangered by the Fish and Game Commission or a federal fish or wildlife agency or would cause significant, long-term damage to listed species. To make a determination as to the effect of a THP on listed fish or wildlife species, CDF routinely consults with other state agencies and notifies federal fish and wildlife agencies. These processes and independent internal review by CDF biologists can result in a THP containing additional site-specific mitigation measures similar to the ones described in the Proposed Action/Proposed Project alternative. CDF believes that its existing process using the FPRs and the CEQA THP-by-THP review and mitigation are sufficient to avoid take of listed species.

The mitigation by which an individual THP is determined to comply with FPRs, the FESA and CESA, and other federal and state laws is determined first by compliance with specific standards in the FPRs and then by development of site-specific mitigation measures in response to significant effects identified in the CEQA functional equivalent environmental analysis of the individual THP. Compliance is attained by a wide variety of detailed mitigation measures tailored to local conditions including, but not limited to, consideration of slope stability, erosion hazard, road and skid trail location, WLPZ width, BMPs on hillslopes and within WLPZs, and wildlife and fish habitat. Consequently, most significant effects of individual THPs can be expected to be mitigated to a level of less than significant through implementation of the No Action/No Project alternative. In some cases, CDF may determine that it is not feasible to mitigate a significant effect of a THP to a level of less than significant. In such a situation, CDF would need to determine whether specific provisions of the FPRs such as not allowing take of a listed threatened or endangered species would prohibit CDF from approving the THP. If approval is not specifically prohibited, CDF would need to weigh a variety of potentially competing public policies in deciding whether to approve the THP. A THP with a significant remaining effect could be approved with a statement of overriding considerations, but such an approval would be expected to be rare.

As noted in Section 2.5, under NEPA the degree of analysis devoted to each alternative in the EIS will be substantially similar to that devoted to the Proposed Action/Proposed Project. The federal agencies recognize that a wide variety of potential strategies could be applied that could represent a No Action/No Project scenario and that they would involve consideration of the same mitigation measures as described above. For the purposes of analysis under NEPA, however, these additional mitigation measures are represented as RMZs, rather than management options developed for site-specific conditions. Consequently, the analysis of the No Action/No Project alternative considers the implementation of wide, no-harvest RMZs as well as restrictions on the harvest of old-growth redwood forest to model conditions over the short and long term. Ranges of RMZ width are considered qualitatively because adequate buffer widths could vary as a result of varying conditions on PALCO lands.

As noted above, the evaluation of the No Action/No Project alternative differs under CEQA and NEPA. For CEQA the No Action/No Project alternative is not projected into the long-term future. In the short term, the conformance with the FPRs, the FESA and the CESA, and other federal and state laws is determined on a THP- and site-specific basis. A wide variety of mitigation measures tailored to local conditions is applied with the purpose of avoiding significant environmental effects and take of listed species. Consequently, most significant environmental effects of individual THPs can be expected to be mitigated to a level of less than significant through implementation of the No Action/No Project alternative.

As noted in Section 2.5 and Section 3.4.3.2, the NEPA evaluation of the No Action/No Project alternative considers the implementation of wide, no-harvest RMZs as well as restrictions on the harvest of old-growth redwood forest to model conditions over the short and long term. Ranges of RMZs are considered qualitatively because adequate buffer widths could vary as a result of varying conditions on PALCO lands.

The potential for peak flow effects due to timber harvest are related to the amount of timber harvested in relation to the basin size. If timber harvest occurs over a large watershed, there may be peak flow increases at any order watershed . However, HUs would not be entirely harvested at the same time. Therefore, increases in peak flows may occur in the first and second order watersheds in the portions of the HU that would be harvested, but not in the entire HU (Ziemer, 1998).

As discussed in Section 3.4.2, the primary effect related to timber harvest alone would be moderate increases in flow in small basins, particularly during the first storms of the wet season. While thresholds for peak flow effects are not well defined, and most of the studies conducted have been on watersheds much smaller than the planning watersheds, it can be reasoned that the more timber harvest that occurs, the more likely there will be increases in peak flow.

In studies of small tributary watersheds less than 40 acres in the Caspar Creek watershed, there was a 35 percent mean peak flow increase for clearcut tributary watersheds and a 16 percent increase for partially clearcut tributary watersheds for flows that occur less frequently than twice a year (i.e., saturated soil mantle conditions) (Ziemer, 1998).

In first- and second-order drainages that may be harvested within HUs that are planned for intensive harvest, there may be increases in peak flows. The potential increase in flows could result in streambed scour, thereby increasing turbidity and suspended sediment to levels higher than before timber harvest. In larger basins such as HUs, the effects on peak flows would be attenuated and would not result in a measurable difference in peak flows. Therefore, there would be minimal effects related to peak flows at the HU level.

ALTERNATIVE 2 (PROPOSED ACTION/PROPOSED PROJECT)

This alternative would have similar effects on peak flows as Alternative 1. The amount of forest in riparian areas would be smaller, and five percent more late seral forest would be maintained at all times. Because of the forest set aside in MMCAs, the potential for increased peak flows may be reduced somewhat, but it is unlikely that the effect would be noticeably different than Alternative 1, since the overall harvest levels would be similar.

Based on timber harvest modeling (PALCO, 1998) the amount and distribution of timber harvest is known only for the first 10 years. After 10 years, the resolution of timber harvest data is reduced to the level of WAA. Most of the WAAs, as defined, are not meaningful for evaluating watershed-level effects, since more than one watershed may be included

Table 3.4-7. Acres of Harvest by HU in the first 10 years

WAA	Hydrologic Unit	Total Acres	PALCO Ownership Total	PALCO Harvest in First 10 years	% of PALCO Ownership Harvested	% of Total Acres Harvested by PALCO
Bear/Mattole River	Bear River	66294	16538	2252	14	3
	Mattole Delta	56471	3869	648	17	1
	Middle Mattole	54967	30	0	0	0
	NF Mattole River	22765	5317	1525	29	7
	Upper NF Mattole	17502	8788	1118	13	6
Bear/Mattole River Total		*218001*	*34543*	*5543*	*16*	*3*
Eel River	Eel Delta	91612	10645	3700	35	4
	Giants Ave	132969	2247	1072	48	1
	Larabee Cr	56370	15009	5678	38	10
	Lower Eel	44266	36016	11802	33	27
	Sequoia	100956	11576	3982	34	4
Eel River Total		*426174*	*75493*	*26234*	*35*	*6*
Humboldt Bay	Elk River	33838	22205	5826	26	17
	Freshwater Cr	27666	15427	6724	44	24
	Jacoby Cr	13028	379	26	7	0
	Other	41109	157	20	13	0
	Salmon Cr	13001	624	176	28	1
Humboldt Bay Total		*128641*	*38793*	*12772*	*33*	*10*
Mad River	Butler Valley	53098	1805	96	5	0
	Iaqua Buttes	39056	2099	90	4	0
Mad River Total		*92154*	*3905*	*186*	*5*	*0*
Van Duzen River	Van Duzen WAA	55367	24945	4286	17	8
Van Duzen River Total		*55367*	*24945*	*4286*	*17*	*8*
Yager Creek	Lawrence Cr	26927	15181	1672	11	6
	Lower Yager	14747	14423	2423	17	16
	Middle Yager	12816	2401	791	33	6
	North Yager	30105	2117	997	47	3
Yager Creek Total		*84594*	*34123*	*5883*	*17*	*7*
Grand Total		**1004931**	**211801**	**54904**	**26**	**5**

Source: Foster Wheeler Environmental Corporation

in a WAA. Therefore only the effects during the first decade of harvest can be evaluated. Assuming that the magnitude and distribution of timber harvest would be similar in subsequent decades (within the remaining unharvested areas), the hydrological effects would also be similar.

During the first ten years of the HCP, several HUs would be more intensively harvested which include Elk River (17 percent of total HU), Lower Eel (27 percent of total HU), and Freshwater Creek (24 percent of total HU) (Table 3.4-7; PALCO 1998, Volume 5, Map 17). In the first and second order drainages that may be harvested within these HUs, there may be increases in peak flows. The potential increase in flows could result in scour thereby increasing turbidity and suspended sediment to levels higher than prior to timber harvest. In larger basins such as HUs, the effects on peak flows would be attenuated , and would not result in a measurable difference in peak flows. Therefore, there would be minimal effects related to peak flows at the HU level.

ALTERNATIVE 2A (NO ELK RIVER PROPERTY)

This alternative would be nearly identical in effects on peak flows as Alternative 2. Elk River Timber Company would have similar amounts of harvest and road building in the Elk River HU. One difference is that in the Elk River HU, timber harvest at any given time would be slightly less than under Alternative 2, since Elk River Timber Company would have to use the buffers designed for coho salmon protection. Overall, effects on peak flows would be similar to Alternative 2.

ALTERNATIVE 3 (PROPERTY-WIDE SELECTIVE HARVEST)

The potential for increased peak flows related to timber harvest alone would be significantly less than under Alternative 2; with selective harvest as the exclusive method, timber harvest would presumably be widely dispersed across the PALCO ownership, and thus no significant short- or long-term effect is expected.

Within the Elk River HU, the Headwaters Reserve would protect a substantial proportion of the watershed. Therefore, within this HU, there would be minimal effects.

ALTERNATIVE 4 (63,000-ACRE NO-HARVEST PUBLIC RESERVE)

The effects of this alternative would be similar to Alternative 2; the only significant difference is that there would be no increased peak flows related to harvest in the Reserve. In the HUs where the 63,000-acre Reserve is located (North, Middle, and Lower Yager; Elk River, Lawrence, and Salmon HUs), there would be no potential for this effect after recently harvested areas grow back.

Summer Low Flows

THRESHOLD OF SIGNIFICANCE

Because the likely effect of any of the alternatives would be a beneficial increase in summer low flows, there is no threshold of significance for low flows.

ALTERNATIVE 1 (NO ACTION/NO PROJECT)

As noted in Section 2.5 and Section 3.4.3.2, the evaluation of the No Action/No Project alternative differs under CEQA and NEPA. For CEQA the No Action/No Project alternative is not projected into the long-term future. In the short term, the conformance with the FPRs, the FESA and the CESA, and other federal and state laws is determined on a THP- and site-specific basis. Compliance is attained by a wide variety of mitigation measures tailored to local conditions such that significant environmental effects and take of listed species are avoided. Consequently, most significant environmental effects of individual THPs can be expected to be mitigated to a level of less than significant through implementation of the No Action/No Project alternative.

As noted in Section 2.5 and Section 3.4.3.2, the NEPA evaluation of the No Action/No Project alternative considers the implementation of wide, no-harvest RMZs as well as restrictions on the harvest of old-growth redwood forest to model conditions over the short and long term. Ranges of RMZs are considered qualitatively because adequate buffer widths could vary as a result of varying conditions on PALCO lands.

Summer flows may increase where timber harvest rate is the greatest. Significant effects on low flows during the first two decades of the SYP would occur in the same areas as the effects on peak flows. These areas include Freshwater Larabee, Lower Eel, Upper North Fork Mattole, North Fork Mattole, and North Fork Yager HUs. However, these increases in flows would last for only a few years after timber harvest, and the level of increase may be small.

ALTERNATIVES 2 (PROPOSED ACTION/PROPOSED PROJECT) AND 2A (NO ELK RIVER PROPERTY)

Under this alternative, timber harvest rates would be greater than under Alternative 1. Summer low flows would be roughly similar to or slightly higher, than under Alternative 1, with temporary increases in summer base flow occurring in the watersheds experiencing the fastest rates of timber harvest.

Under Alternative 2a, the effect on summer low flow would be identical to those under Alternative 2, except in the Elk River HU, where the Elk River Timber Company lands would have much larger no-harvest stream buffers, assuming the RMZs in Alternative 1 would be applied. Therefore, impacts to summer low flow in this HU would be the same as under Alternative 1.

ALTERNATIVE 3 (PROPERTY-WIDE SELECTIVE HARVEST)

Under this alternative, a significant amount of the PALCO ownership would be in a no-harvest category, and the remainder of the property would receive a selective harvest prescription. Because the silvicultural prescription WHR6 leaves a substantial number of trees on the landscape, effects on summer low flows would be minimal.

ALTERNATIVE 4 (63,000-ACRE NO-HARVEST PUBLIC RESERVE)

Effects on low flows would be similar to Alternative 2. In the larger Reserve, there would be no timber harvest. Thus, it would have no effect, adverse or beneficial, on low flows.

3.4.3.3 Water Quality Effects

The effects on water quality will be evaluated based upon the likelihood that land management parameters would exceed thresholds of significance for different water quality objectives. The thresholds of significance for water quality are the water quality objectives set forth by the NCRWQCB Basin Plan (NCRWQCB, 1996). Several, but not all, of the water quality objectives would be affected by the management of PALCO lands. These include temperature, dissolved oxygen, water color, sediment, turbidity, floating material, settleable material, biostimulatory substances, pesticides/herbicides, and fecal coliform.

The Basin Plan states that when other factors result in the degradation of water quality beyond the levels or limits established by the NCRWQCB, then controllable factors shall not cause further degradation of water quality. Controllable water quality factors are those actions or conditions, or circumstances resulting from management activities that may influence the quality of the waters of the state and may be reasonably controlled. The controllable management activities that affect the water quality objectives of concern include timber harvest methods, maintenance and construction of roads, burning, grazing, and herbicide application. The parameters that are used to evaluate effects on water quality are shade for temperature; road surface erosion, hillslope erosion, road-related and timber-harvest-related mass wasting, grazing, and burning for sediment related water quality parameters; temperature for dissolved oxygen; hillslope erosion and burning for biostimulatory substances (nutrients); herbicide application and management for herbicides; and cattle grazing for fecal coliform. Exceeding the threshold of significance is based upon the reasonable and controllable management activities (including associated BMPs and prescriptions) and their effects on the individual water quality parameters. The conclusions in this section rely upon the analysis presented in Section 3.6, Soils and Geomorphology, and Section 3.7, Wetlands and Riparian Lands.

Threshold of Significance for Temperature

The threshold of significance for temperature is the water quality objective for cold water streams as stated in the Basin Plan. The objective states that at no time or place shall the temperature of any receiving water be increased by more than 5°F above natural receiving water temperature. It also states that the water temperature shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses, including fish and wildlife.

WATER TEMPERATURE

Many different heat exchange processes, as discussed in Section 3.4.2.2, interact to regulate stream temperature. The dominant influence is the input of solar radiation. Canopy closure and its shading effects reduce the input of solar radiation reaching the stream. For this analysis, canopy closure and shade are the most measurable and predictable parameters used to analyze the land management effects on stream temperature.

Alternative 1 (No Action/No Project)

As noted in Section 2.5 and Section 3.4.3.3, the evaluation of the No Action/No Project alternative differs under CEQA and NEPA. For CEQA the No Action/No Project alternative is not projected into the long-term future. In the short term, the conformance with the FPRs, the FESA and the CESA, and other federal and state laws is determined on a THP- and site-specific basis. Compliance is attained by a wide variety of mitigation measures tailored to local conditions such that significant environmental effects and take of listed species are avoided. Consequently, most significant environmental effects of individual THPs can be expected to be mitigated to a level of less than significant through implementation of the No Action/No Project alternative.

As noted in Section 2.5 and Section 3.4.3.3, the NEPA evaluation of the No Action/No Project alternative considers the implementation of wide, no-harvest RMZs as well as restrictions on the harvest of old-growth redwood forest to model conditions over the short and long term. Ranges of RMZs are considered qualitatively because adequate buffer widths could vary as a result of varying conditions on PALCO lands.

The no-harvest buffer widths in Alternative 1 RMZs would maintain or improve current stream temperatures on

PALCO lands. These no-harvest buffers range from 170 to 340 feet for Class I and from 85 to 170 feet for Class II streams. The buffers provide full protection for shade and thus stream temperature (see Riparian Environmental Effects in Section 3.7) Open areas and young forest along streams would mature in the next 10 to 20 years and improve stream shade and temperatures.

Alternative 2 (Proposed Action/Proposed Project)

Alternative 2 provides different RMZ prescriptions than Alternative 1, but should maintain or improve stream temperatures compared to existing conditions (see Wetlands and Riparian Lands in Section 3.7).

The 170-foot RMZs for Class I streams include a 100-foot, no-cut buffer adjacent to each side of the watercourse and a 70-foot selective harvest outer band from 100 to 170 feet. The 130-foot RMZs for Class II streams (100-foot RMZs in the Humboldt WAA) include a 30-foot, no-cut buffer adjacent to each side of the watercourse. The outer band (30 to 130 feet [100 feet in the Humboldt WAA]) is a selective harvest band with specific prescriptions for different slope classes (see Section 3.7, Wetlands and Riparian Areas). For both Class I and Class II streams, the no-harvest buffers may be modified by watershed analysis prescriptions to no more than 170 feet (horizontal measurement) and to no less than 30 feet (slope measurement) on each side of the watercourse. Along Class II streams, the no-cut buffers may be modified by watershed analysis and may be reduced to a minimum of 10 feet if the FWS and NMFS determine it will benefit aquatic habitat or species.

Grazing could significantly affect shade and stream water temperatures in localized areas. Watershed analysis would specifically address grazing issues where applicable.

In conclusion, the RMZ prescriptions provide adequate shade in all areas when compared to baseline conditions. Additionally, regrowth of trees along streams in currently open areas and young forest, and the management under the prescriptions when the trees mature, would improve stream temperatures compared to existing conditions in those areas over the next 10 to 20 years and through the remainder of the HCP. Overall, there is a less-than-significant effect and a beneficial effect to stream temperature in Alternative 2 for Class I and Class II streams.

In the Headwaters Reserve, water temperatures would remain within acceptable limits, because the 2,313 riparian acres would be protected. Where applied, watershed analysis and trend monitoring would identify sensitive areas for shade/stream temperature and provide site-specific prescriptions when necessary to maintain or improve the shade component of streams.

Alternative 2a (No Elk River Property)

Alternative 2a would have similar effects as Alternative 2, except fewer streams would be affected in the Elk River HU. Stream shade and stream temperatures would be maintained or improved on all Class I streams and most Class II streams. Overall, however, there is a less than significant and beneficial effect to stream temperature in Alternative 2a for Class I and Class II streams.

Alternative 3 (Property-wide Selective Harvest)

Alternative 3 would provide adequate shade to maintain or improve stream water temperature (see Wetlands and Riparian Areas in Section 3.7). The prescribed no-harvest buffer widths (minimum 100 feet for Class I streams, 75 feet for Class II streams) would maintain or improve stream temperatures on PALCO property. Stream water temperatures in the no-harvest Headwaters Reserve would be fully protected. Over time, throughout the life of the HCP, the young forests would improve stream temperature conditions in HUs where riparian seral stage is young or open forest. There is no significant effect to stream temperature under this alternative.

Alternative 4 (63,000-acre No-harvest Public Reserve)

Alternative 4 would provide the same level of protection to streams on PALCO lands as Alternative 2. Stream shade and stream temperatures would be maintained or improved on all Class I streams and most Class II streams. Consequently, there is a less than significant and beneficial effect to stream temperature in Alternative 4 for Class I and Class II streams.

The no-harvest management of the 63,000-acre Reserve would maintain and improve canopy closure and stream temperatures in the HUs of the Reserve. Stream temperatures would improve over time in current open areas and young forests. There is a less than significant effect to stream temperature under this alternative.

DISSOLVED OXYGEN

The threshold of significance for DO ranges between 7 and 10 mg/l depending upon the river system. Specific standards for certain rivers are described in the Basin Plan.

All Alternatives

There would be no significant effects on DO from timber harvest activities in the streams on PALCO lands. The RMZs would protect stream temperature and probably DO levels.

SEDIMENT-RELATED WATER QUALITY OBJECTIVES—SUSPENDED SEDIMENT, TURBIDITY, COLOR, SETTLEABLE MATERIAL, FLOATING MATERIAL

To evaluate the alternatives in relationship to these NCRWQCB water quality objectives, all the potential sediment sources to streams and the efforts to reduce sediment delivery under each alternative were considered. Section 3.6, Soils and Geomorphology, discusses each component of management-related sedimentation. This section discusses the effect of all sediment sources combined. Sediment that reaches streams can be divided into fine and coarse fractions, each having different effects. Fines from hillslope erosion and road surface erosion contribute directly to turbidity problems and tend to cause temporary impacts to water quality, especially during the peak flows during the rainy season. Slightly larger sediment and fines that settle out within the channel may cause temporary or persistent embeddedness impacts.

Timber-harvest- and road-related sediment may be delivered to any stream in a watershed. However, because of the high number of Class III stream miles on PALCO lands, the management activities in the vicinity of Class III streams can be an important contributor to downstream Class II and Class I streams. A 1995 CDF survey of resource professionals' opinions of WLPZ effectiveness indicated that the protection of Class III watercourses and prevention of sediment from entering Class I and Class II streams via Class III streams needed improvement in some situations (CDF, 1995). Personnel responding to the survey gave examples where road-related sediment, lack of BMPs, tractor yarding, positioning of drainage structures, landing construction and use, maintenance of inside ditches and winter operations have resulted in direct discharge of sediment to Class III watercourses, resulting in movement of "significant" amounts of sediment into Class I and Class II streams (CDF, 1995).

THRESHOLDS OF SIGNIFICANCE FOR SEDIMENT

For CEQA, the threshold of significance for sediment delivery to streams is based upon the reduction of management-related sediment such that discharge to streams will not degrade or impede the recovery of beneficial uses. Background turbidity would include some continuing effects of logging activity, grazing, and burning during a particular storm prior to any timber harvest, while natural turbidity would be the turbidity that occurs during a particular storm before any timber harvest or other ground-disturbing management activities. Therefore, the exceedance of a threshold of significance for sediment is evaluated based upon whether adequate management for sediment reduction would occur under each alternative. That is, the thresholds for suspended sediment, turbidity, settleable material, floating material, and color are evaluated in relationship to proposed management measures that reduce sediment delivery. Components of management practices discussed above (yarding, road building, and road use) are evaluated for significance individually in Section 3.6, Soils and Geomorphology. This separate discussion is necessary to consider the effects of management on each impact mechanism.

Alternative 1 (No Action/No Project)

As noted in Section 2.5 and Section 3.4.3.3, the evaluation of the No Action/No Project alternative differs under CEQA and NEPA. For CEQA the No Action/No Project alternative is not projected into the long-term future. In the short term, the conformance with the FPRs, the FESA and the CESA, and other federal and state laws is determined on a THP- and site-specific basis. Compliance is attained by a wide variety of mitigation measures tailored to local conditions such that significant environmental effects and take of listed species are avoided. Consequently, most significant environmental effects of individual THPs can be expected to be mitigated to a level of less than significant through implementation of the No Action/No Project alternative.

As noted in Section 2.5 and Section 3.4.3.3, the NEPA evaluation of the No Action/No Project alternative considers the implementation of wide, no-harvest RMZs as well as restrictions on the harvest of old-growth redwood forest to model conditions over the short and long term. Ranges of RMZs are considered qualitatively because adequate buffer widths could vary as a result of varying conditions on PALCO lands.

Under this alternative, there are no explicit measures or management controls to reduce or protect the streams from the delivery of fine and coarse sediment above FPRs other than by the additional filter strip capacity provided by larger riparian buffers. The highly protective no-harvest buffers can filter some percentage of fine sediment from hillslope erosion (see Section 3.6, Soils and Geomorphology, and Riparian Environmental Effects in Section 3.7). Road surface erosion and road failures, however, would continue to be a major contributor of fine and coarse sediment. There are no explicit measures to prevent or reduce road surface erosion or potential road-stream crossing failures (see Section 3.6, Soils and Geomorphology). Although PALCO currently conducts road maintenance and has stormproofed some roads, no systematic stormproofing program would be implemented under this Alternative. Consequently, road fill and stream crossing failures would be a significant source of sediment in streams during large storm events. Sediment delivery to streams due to management activities would have the potential to degrade water quality and its beneficial uses.

CDF has listed the Elk River watershed (Elk River HU), Freshwater Creek watershed (Freshwater Creek HU), Jordan Creek watershed (Lower Eel HU), Bear Creek watershed (Lower Eel HU), and Stitz Creek watershed (Lower Eel HU) as cumulatively impacted by sediment. All approved THPs in these watersheds must be shown not to have a reasonable potential to add to past, present, or reasonably foreseeable cumulative effects to anadromous fish habitat including coho salmon habitat and not to impede recovery of coho salmon and their habitat. The future management in these specific drainages will reduce controllable sediment.

Alternatives 2 (Proposed Action/ Proposed Project) and 2a (No Elk River Property)

This alternative includes a variety of specific management actions to control sediment from timber-harvest-related mass wasting, road-related mass wasting/stream crossing erosion, road surface erosion, and hillslope erosion. Management actions used to control sediment for harvest-related mass wasting include a detailed set of BMPs and prescriptions (Appendix E). Additionally, it is PALCO's intent to use more detailed and site-specific watershed analysis procedures and implementation of watershed analysis prescriptions on PALCO property. The watershed analysis process is used to evaluate watershed processes such as slope stability, hillslope erosion, riparian function, water flow patterns, and stream channel conditions and their effects on water quality, fish and fish habitat, and capital improvements. The scientific analysis results in the development of watershed-specific management prescriptions. Appendix G provides a description of the watershed analysis process. Once a watershed analysis has been approved, the prescriptions would be used in those areas where harvest and road activity may occur.

Management controls for road-related mass wasting, road surface erosion, and stream crossing erosion would include a sediment assessment and implementation plan with a road armoring plan, as well as a road construction and maintenance plan. Hillslope erosion management includes RMZs which serve to filter overland delivery of sediment. The management for these sediment sources is described in detail in Section 3.6, Soils and Geomorphology. The prescriptions for wet weather road use and winter road construction in this alternative (Appendix F of the PALCO HCP) adequately address and mitigate for the "controllable" delivery of sediment to streams.

The prescriptions for road construction do not allow new road construction and stormproofing during the winter period (October 15 to May 1). Road construction would also not occur during periods of measurable precipitation.

In addition, the wet weather road use prescriptions in the Draft HCP present a moderate risk to water quality. This risk has been minimized to a level of less than significant because the HCP requires that road use activities cease when activities result in a visible increase in turbidity in any drainage facility or road surface that drains directly to a Class I, II, or III watercourse, or a visible increase in turbidity in any Class I, II, or III watercourse.

The watershed analysis and road maintenance program would be applied on a prioritized and systematic basis (see Appendix E under Road Network). In the first decade, the Elk River, Lawrence Creek, Freshwater Creek, Yager Creek (including Lower, North Fork, Middle, and South Fork) watersheds would be treated.

In the second decade, the Van Duzen and Middle Eel River watersheds would be treated. In the third decade, the Larobee/Sequoia, Mattole Salmon, and Bear watersheds would be treated. Consequently, over time there would be a systematic reduction in road-related sediment influxes on the PALCO property. This reduction would provide substantial improvements in aquatic habitat (see Section 3.8, Fish and Aquatic Habitat).

The major contributor of deliverable stream sediment in the Headwaters Reserve for these alternatives would be road stream crossing failures and road-related landslides. Specific maintenance, improvements, and mitigation of the roads are not part of the alternatives; consequently, potential road failures would contribute sediment directly into streams in the Reserve until rehabilitation is implemented under the schedule of activities developed for the Reserve. Implementation of these restoration activities would likely begin shortly after acquisition (Appendix D). The sediment contributions would be significant to streams and water quality and could exceed the thresholds of significance for sediment-related water quality objectives until rehabilitation measures are implemented.

Grazing could significantly affect sediment delivery in localized areas. Watershed analysis would specifically address grazing issues where applicable.

Based on public comments and FESA and CESA issuance criteria, the wildlife agencies consider that additional mitigation would be appropriate to reduce the risk of potential adverse effects. These additional mitigation measures would further reduce the impacts as described in the Draft and Final EIS/EIR. This additional mitigation is summarized in Section 3.4.3.8. Detailed descriptions of the mitigation measures are provided in Appendix P.

Alternative 3 (Property-wide Selective Harvest)

Under this alternative, wide no-harvest buffers (see Section 3.7) and no-harvest old-growth areas which substantially reduce the amount of timber harvest on PALCO lands, and the systematic reduction in road-related sediment in the Freshwater, Elk River, Lower Eel, Bear Creek, and Jordan Creek planning watersheds would reduce road- and timber-management-related sediment in the short, mid, and long term. Specific treatment of road-generated sediment delivery to streams and the passive management of RMZ prescriptions would result in a less-than-significant effect on water quality for the sediment parameters. This alternative is the most protective of water quality and its beneficial uses. There is a less-than-significant effect on water quality from sediment delivery to streams. The length of time for major sediment reduction to be observable is the same as for Alternatives 2 and 4.

Alternative 4 (63,000-acre No-harvest Public Reserve)

Alternative 4 is similar to Alternative 2 except management would occur over a smaller area because of the 63,000-acre Reserve. This alternative addresses and mitigates for the controllable delivery of sediment to streams outside of the Reserve in the same way as Alternative 2. Management controls for road-related mass wasting, road surface erosion, and stream crossing erosion include a sediment assessment and implementation plan with a road armoring plan, as well as a road construction and maintenance plan. Hillslope erosion management includes RMZs which serve to filter overland delivery of sediment. The management for these sediment sources is described in detail in Section 3.6, Soils and

Geomorphology. In addition, watershed analysis and the implementation of the management prescriptions would further reduce management-related sediment delivery to streams. The management controls and watershed analysis would result in a less-than-significant effect on sediment-related water quality objectives. The length of time for major sediment reduction to be observable would be the same as in Alternatives 2 and 4.

All potential timber harvest effects in the Reserve would be greatly reduced compared to existing conditions. A short-term increase in road-related sediment could occur due to diminished road maintenance until restoration activities would be implemented shortly after acquisition (Appendix D). There is a less-than-significant effect on water quality from sediment in the 63,000-acre Reserve.

THRESHOLDS OF SIGNIFICANCE FOR NUTRIENTS- BIOSTIMULATORY SUBSTANCES

The threshold of significance for biostimulatory substances such as nitrates is the NCRWQCB water quality objective. The objective states that waters shall not contain biostimulatory substances in concentrations which promote aquatic growths to the extent of causing nuisance or adversely affecting beneficial uses. Hillslope surface erosion would be the main delivery source of soil and organics to streams.

Alternative 1 (No Action/No Project)

As noted in Section 2.5 and Section 3.4.3.3, the evaluation of the No Action/No Project alternative differs under CEQA and NEPA. For CEQA the No Action/No Project alternative is not projected into the long-term future. In the short term, the conformance with the FPRs, the FESA and CESA, and other federal and state laws is determined on a THP- and site-specific basis. Compliance is attained by a wide variety of mitigation measures tailored to local conditions such that significant environmental effects and take of listed species are avoided. Consequently, most significant environmental effects of individual THPs can be expected to be mitigated to a level of less than significant through implementation of the No Action/No Project alternative.

As noted in Section 2.5 and Section 3.4.3.3, the NEPA evaluation of the No Action/No Project alternative considers the implementation of wide, no-harvest RMZs as well as restrictions on the harvest of old-growth redwood forest to model conditions over the short and long term. Ranges of RMZs are considered qualitatively because adequate buffer widths could vary as a result of varying conditions on PALCO lands.

Under Alternative 1, the RMZs on all stream classes would reduce hillslope erosion (see Section 3.6, Soils and Geomorphology). The major source of fine sediment and organic matter would be eliminated; road surface erosion and road-related mass wasting may deliver sediment to streams, but should not affect nutrient loading because road fill is mostly devoid of organic materials. The effects of burning may increase nitrate levels in localized streams for short periods of time if riparian areas inadvertently get burned. The RMZs would filter most hillslope erosion, and inputs of phosphorus would be reduced. There are no substantial changes in nitrogen and phosphorus levels under this alternative.

Alternative 2 (Proposed Action/Proposed Project)

The sediment assessment and reduction plan in addition to the RMZs in Alternative 2 would reduce the delivery of fine sediment to streams, especially measures to reduce hillslope erosion. The RMZs would filter most of the fine sediment from hillslope erosion along most streams (see

Section 3.6, Soils and Geomorphology). No-harvest zones on Class I streams and Class II streams would filter sediment from hillslopes, while EEZs, ELZs, and BMPs would decrease direct delivery of sediment from hillslope erosion adjacent to Class III streams. Other hillslope mitigation measures include waterbreaks along skid trails and treatment of exposed mineral soils. Consequently, erosion from hillslopes would be a minor source of sediment delivery to streams under this alternative. The effects of burning may increase nitrate levels in localized streams for short periods of time if riparian areas inadvertently get burned. As indicated above, forest practices are unlikely to substantially increase nutrient concentrations in aquatic systems. Under the proposed SYP, however, PALCO would conduct an intensive forest management program including potential forest fertilization. Based on the management practices described above and restrictive use of fertilizers in RMZs, effects on water quality would be expected to be minimal. Overall, the effects of management are less than significant for CEQA purposes, to biostimulatory substance effects on water quality in streams on PALCO lands. There would be no significant effect on water quality from nutrients in the Headwaters Reserve.

Based on public comments and FESA and CESA issuance criteria, the wildlife agencies consider that additional mitigation would be appropriate to reduce the risk of potential adverse effects. These additional mitigation measures would further reduce the impacts as described in the Draft and Final EIS/EIR. This additional mitigation is summarized in Section 3.4.3.8. Detailed descriptions of the mitigation measures are provided in Appendix P.

Alternative 2a (No Elk River Property)

The effects under this alternative would be similar to Alternative 2 except less land in the Elk River HU would be susceptible to delivery of fine sediment and organic material to streams. RMZs, EEZs, ELZs, BMPs, no prescribed burning in RMZs along Class I and Class II streams, and specific hillslope mitigation measures would reduce the delivery of soil, fine sediment, and organic matter to streams. The effects of management are less than significant for CEQA purposes, on biostimulatory substance effects to water quality in streams on PALCO lands. There is no significant effect on water quality from nutrients in the Headwaters Reserve. Elk River Timber Company Lands would have similar effects as Alternative 1; there would be no significant effect on water quality on Elk River Timber Company Lands from the delivery of biostimulatory substances to streams.

Alternative 3 (Property-wide Selective Harvest)

This alternative does not have specific requirements regarding hillslope erosion, so the FPRs would be used as a default. Although there is potential for hillslope erosion under the FPRs, there would be a substantial amount of protection against sediment delivery to streams. In addition, over 40,000 acres of PALCO lands would be no-harvest because of old-growth reserves and large no-harvest buffers along all streams. The rest of the property would be harvested under the PALCO late seral prescription, which would minimize the amount of soil exposed to erosion by tractor logging. The large no-harvest restrictions from the old-growth areas and the highly protective RMZs would minimize the delivery of fine sediment and soil to streams to a greater extent than any other alternative. Under this alternative, however, the potential would exist for extensive road construction as PALCO accessed land for selective harvest. This road construction could offset water quality. The lack of sediment and reduced burning would not have a significant effect on water quality from nitrogen and phosphorus inputs from organic matter and soil.

Alternative 4 (63,000-acre No-harvest Public Reserve)

The PALCO lands not in the 63,000-acre Reserve would have the same treatment and the same effects as Alternative 2. RMZs, EEZs, ELZs, BMPs, no prescribed burning in RMZs along Class I and Class II streams, and specific hillslope mitigation measures would reduce the delivery of soil, fine sediment, and organic matter to streams. The effects of management are less than significant to biostimulatory substance effects on water quality in streams on PALCO lands. Similar to Alternative 2, there would be minimal effects of potential forest fertilization on water quality.

There would be no significant effect on water quality from nutrients in the 63,000-acre Reserve. There would be no management-related fine sediment and organic matter delivery to streams from hillslope erosion in the 63,000-acre Reserve because the Reserve would not be managed for timber harvest.

THRESHOLDS OF SIGNIFICANCE FOR PESTICIDES/HERBICIDES

The thresholds of significance for pesticides and herbicides are outlined in the California NCRWQB Basin Plan. The objective states no individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. In addition, the objective states there shall be no bioaccumulation of pesticide concentrations found in bottom sediments or aquatic life. See Section 3.14, Herbicides, for a more detailed discussion of the effects of pesticides and herbicides.

Alternative 1 (No Action/No Project)

As noted in Section 2.5 and Section 3.4.3.3, the evaluation of the No Action/No Project alternative differs under CEQA and NEPA. For CEQA the No Action/No Project alternative is not projected into the long-term future. In the short term, the conformance with the FPRs, the FESA and CESA, and other federal and state laws is determined on a THP- and site-specific basis. Compliance is attained by a wide variety of mitigation measures tailored to local conditions such that significant environmental effects and take of listed species are avoided. Consequently, most significant environmental effects of individual THPs can be expected to be mitigated to a level of less than significant through implementation of the No Action/No Project alternative.

As noted in Section 2.5 and Section 3.4.3.3, the NEPA evaluation of the No Action/No Project alternative considers the implementation of wide, no-harvest RMZs as well as restrictions on the harvest of old-growth redwood forest to model conditions over the short and long term. Ranges of RMZs are considered qualitatively because adequate buffer widths could vary as a result of varying conditions on PALCO lands.

Under this alternative, there would be no herbicide application in the vicinity of all streams because of the wide, no-harvest RMZs. Because most herbicide application in the North Coast region is ground based (Personal communication, Frank Reichmuth, NCRWQCB, 1998), there would be little potential for wind drift aerial herbicide spraying to enter streams in measurable quantities. However, the use of atrazine increases the potential for groundwater contamination. Water quality monitoring for herbicides by the NCRWQCB has not detected any contamination or exceedance of water quality objectives from herbicides in the

Region. There would be no substantial changes from herbicides on water quality.

Alternatives 2 Proposed Action/ Proposed Project) and Alternative 2a (No Elk River Property)

Increased herbicide use would occur under this alternative because of the intensive harvest of PALCO lands. Under this alternative and sub-alternative, herbicide application would not occur within RMZs along Class I and Class II streams. However, there is potential for herbicide-adsorbed sediment to be delivered to Class III streams and enter the aquatic system during storm events, as well as potential for atrazine to contaminate the groundwater. Water quality monitoring for herbicides by the NCRWQCB has not detected any contamination or exceedance of water quality objectives from herbicides in the Region. Consequently, there is a less-than-significant effect for CEQA purposes, on water quality from herbicides under this alternative.

Alternative 3 Property-wide Selective Harvest

The effects under this alternative would be similar to Alternative 1 except less land would be treated with herbicides because of the no-harvest, old-growth areas. Herbicide application would not occur within the no-harvest RMZs. Because most herbicide application in the North Coast region is ground based (personal communication, Frank Reichmuth, NCRWQCB, 1998) there would be little potential for wind drift aerial herbicide spraying to enter streams in measurable quantities. There is no significant effect on water quality under this alternative.

Alternative 4 (63,000-acre No-harvest Public Reserve)

The effects under this alternative would be similar to Alternative 2 except less land would be treated with herbicides because of the 63,000-acre, no-harvest Reserve. The treatment and effects on PALCO land would be the same as Alternative 2. Herbicide application would not occur within RMZs along Class I and Class II streams. However, there is a potential for herbicide-adsorbed sediment to be delivered to Class III streams and enter the aquatic system during storm events. Water quality monitoring for herbicides by the NCRWQCB has not detected any contamination or exceedance of water quality objectives from herbicides in the Region. There are no anticipated significant effects on water quality from herbicides under this alternative.

THRESHOLD OF SIGNIFICANCE FOR FECAL COLIFORM

The threshold of significance for fecal coliform in freshwater streams designated for contact recreation is identified in the Basin Plan. The median fecal coliform concentration based on a minimum not less than five samples for any 30-day period shall not exceed 50 per 100 milliliters (ml), nor shall more than 10 percent of the total samples during any 30-day period exceed 40 per 100 ml, according to the California State Department of Health Services (NCRWQCB, 1996). Cattle grazing is the primary management activity associated with fecal coliform distribution to waterbodies.

All Alternatives

The effects of cattle grazing near streams on PALCO lands may have localized adverse effects on water quality. Approximately 5,000 acres of PALCO lands is leased to private cattle operations along the Mattole/Bear WAA divide, Van Duzen/Eel WAA drainage divide, Bear River/Lower Eel HU divide, and isolated parcels in the Yager Creek WAA. Any localized effects on water quality would occur near waters in the meadow and prairie areas where the cattle graze. The wide dispersion of livestock on PALCO lands would diminish localized effects (see

Effects of Grazing in Section 3.6), and fecal coliform levels exceeding the threshold of significance are not expected. There is no significant effect for CEQA purposes on water quality from fecal coliform on PALCO lands.

Under Alternatives 2, 3, and 4, grazing could significantly affect fecal coliform in localized areas. Watershed analysis would specifically address grazing issues where applicable.

3.4.3.4 Channel Morphology and Floodplains

As discussed in Section 3.4.2.3, channel morphology can be modified by changes in three factors: coarse sediment influx, decreased streambank stability, and decreases in LWD recruitment. Increases in peak flows can also affect channel morphology. However, it was established in Section 3.4.3.1 that only smaller channels might be affected due to extension of the drainage network through roads. Gravel mining, which directly affects channel morphology and floodplains, is discussed separately in Section 3.4.3.6.

Thresholds of Significance

CHANNEL MORPHOLOGY AND FLOODING

Each stream is characterized by a range of sediment flux; channel morphology is in part determined by that flux. It is not possible to quantify sediment flux for each alternative due to the scale and complexity of the stream system. Therefore, for the purposes of this EIS/EIR, the threshold of significance is the probability of a detectable change in channel morphology, either in cross-section longitudinal profile, or plan form. To help frame the evaluation of significance, channel changes are deemed significant if 1,000 feet or more of a channel, measured on an aggregate basis, is likely to experience scour or aggradation of one foot or more. Although there is a relationship between storm event size and channel changes, the analysis does not consider this relationship. Significance is evaluated, however, with respect to the risk of coarse sediment influx from hillslope or road-related mass wasting. Specific aspects of channel morphology such as pool frequency, depth, and spacing are not specifically evaluated here.

FLOODPLAINS

The threshold of significance for floodplain effects is relative to the change in flood storage. A change in the flood storage capacity, caused by aggradation or construction, sufficient to substantially increase overbank flooding is considered significant.

FLOODPLAINS—ALL ALTERNATIVES

There are no plans under any of the alternatives to build within the floodplain of any river in the Project Area. An exception is roads, many of which are located in the floodplain of relatively small channels. However, provided that the roads are not elevated, involving significant amounts of fill, the roads that parallel the floodplain axis would not be expected to have a significant effect.

No excavation or filling of the floodplain is planned, except in relation to gravel mining, which is discussed below. Under each alternative, no additional bridges are planned that would constrict major floodplains, although some small streams may have bridges replaced during typical road maintenance.

Aggradation also affects channel morphology, which in turn affects flooding. The effects of each alternative on aggradation and flooding are considered under Channel Morphology.

3.4.3.5 Channel Morphology

Alternative 1 (No Action/No Project)

As noted in Section 2.5 and Section 3.4.3.5, the evaluation of the No Action/No Project alternative differs under CEQA and NEPA. For CEQA the No Action/No Project alternative is not projected into the long-term future. In the short term, the conformance with the FPRs, the FESA and CESA, and other federal and state laws is determined on a THP- and site-specific basis. Compliance is attained by a wide variety of mitigation measures tailored to local conditions such that significant environmental effects and take of listed species are avoided. Consequently, most significant environmental effects of individual THPs can be expected to be mitigated to a level of less than significant through implementation of the No Action/No Project alternative.

As noted in Section 2.5 and Section 3.4.3.5, the NEPA evaluation of the No Action/No Project alternative considers the implementation of wide, no-harvest RMZs as well as restrictions on the harvest of old-growth redwood forest to model conditions over the short and long term. Ranges of RMZs are considered qualitatively adequate buffer widths could vary as a result of varying conditions on PALCO lands.

Under this alternative wide, no-harvest RMZs would be established on all streams. This would allow for regrowth of trees in RMZs and protection of existing old-growth and late-seral forest in RMZs. The overall effect would be to increase streambank stability by protecting root strength in streambanks and allowing LWD recruitment to recover. There would be a moderate to high risk of changes in channel morphology due to potential for road and timber harvest-related landslides and coarse sediment inputs. Therefore, the potential for destabilizing pulses of sediment would persist. Extreme storm events could have major effects on channel morphology in the Project Area. The influx of coarse sediment could aggrade streams and contribute to lateral erosion in the watersheds with the highest rates of harvest, particularly where there is an LWD deficiency.

Peak flows could cause lateral erosion into the streambanks of small channels. Increased peak flows in first- and second-order watersheds and sediment influx would be more likely in the HUs with high rate of harvest, such as the Freshwater HU.

LWD inputs would gradually increase over time (see Section 3.7, Wetlands and Riparian Lands). However, in areas where LWD was actively removed from streams, LWD may not return to pre-harvest levels for decades. Many of the streams in the Project Area are currently aggrading in at least some reaches. However, this alternative represents the most that can be done to recover LWD functionality as fast as possible, aside from stream dredging and/or placement of LWD in streams. An estimate of LWD recruitment material is provided by the equivalent buffer area index (EBAI). The methodology for the LWD EBAI is presented in Section 3.7, Wetlands and Riparian Lands, and further discussed in Appendix J. Furthermore, this alternative has the highest EBAI values of all alternatives, which indicates much more protection for LWD inputs than any other alternative, and far more protection than under current requirements.

Although the LWD recruitment would increase over time, there would still be both short- and long-term effects on channel morphology due to expected consistent sediment input from existing roads. The magnitude of the effects may diminish slightly over time, as LWD reaches optimum levels, and helps to stabilize channel form. The trend toward background channel patterns and bed elevation would be positive, since much of the hillslope sediment source (riparian zones) would be protected. Because of the lack of control of coarse sediment influxes from road-related mass wasting, the risk to stream channel morphology is considered to be moderate to high. Consequently, the effects of this alternative are considered significant. Section 3.6, Soils and Geomorphology, discusses the risk of coarse sediment influx from road-related mass wasting. The risk under this alternative was determined to be high (i.e., significant). The potential for significant aggradation and related increases in flooding are also considered to be high for this alternative.

The potential for increases in peak flows related to roads have primarily been demonstrated for small to mid-size flows (Jones and Grant, 1996). Under normal channel conditions these potentially small increases would not cause overbank flooding. However, in aggraded channels, small increases in peak flows may cause overbank flooding. In the aggraded channels of the five cumulatively affected watersheds, there is some potential for minor overbank flooding related to road-related peak flow increases. The actual extent or magnitude of such flooding is speculative and unknown. The potential for further aggradation due to increases in sediment is discussed in Section 3.6, Soils and Geomorphology.

Alternative 2 (Proposed Action/Proposed Project)

This alternative provides a substantial amount of protection for channel morphology, with a different approach than in Alternative 1. Although RMZs are narrower and would allow timber harvest to occur within them, other requirements of timber harvest activities maintain appropriate inputs to the aquatic system that affect channel morphology.

Varying levels of harvest are permitted in the RMZs under this alternative. The 170-foot RMZs for Class I streams include a 100-foot, no-cut buffer adjacent to each side of the watercourse and a 70-foot selective harvest outer band from 100 to 170 feet. The 130-foot RMZs for Class II streams (100-foot RMZs in the Humboldt WAA) include a 30-foot, no-cut buffer adjacent to each side of the watercourse. The outer band (30 to 130 feet [100 feet in the Humboldt WAA]) is a selective harvest band with specific prescriptions for different slope classes (see Section 3.7, Wetlands and Riparian Areas). For both Class I and Class II streams, the no-harvest buffers may be modified by watershed analysis prescriptions to no more than 170 feet (horizontal measurement) and to no less than 30 feet (slope measurement) on each side of the watercourse. Along Class II streams, the no-cut buffers may be modified by watershed analysis and may be reduced to a minimum of 10 feet if the FWS and NMFS determine it will benefit aquatic habitat or species. The number of trees remaining, however, would provide a moderate to high level of streambank stability (see Section 3.7, Wetlands and Riparian Lands). On Class III streams, harvest would be allowed to streambank. Consequently, there would be no protection of LWD recruitment potential. PALCO would, however, be required to leave downed trees found adjacent to or within the stream.

Under Alternative 2, a major road improvement program would be instituted. This program would substantially reduce the potential of landslides from the existing road system (see Road-related Mass Wasting in Section 3.6). This reduction would occur systematically over the landscape as the road system was improved over the next three decades (see Section 3.6). Consequently, effects of increased coarse sediment supply would be minimal over time.

Another factor affecting channel morphology is LWD. The EBAI values for

LWD for Alternative 2 are substantially lower than for Alternative 1. However, the level of LWD recruitment for the default prescriptions is considered to be sufficient so that in the long term, the amount of instream LWD would provide the channel roughness elements for creating pools, retaining gravel and protecting streambanks.

Effects of increased peak flows on channel morphology would be the same as under Alternative 1, although the initial lack of LWD could make channels more susceptible to scour. Additionally, in the short term, there would be a risk of coarse sediment input from road-crossing failures while the stormproofing plan is implemented.

Time would be required for the increased LWD input, reduced coarse sediment input, and streambank protection under this alternative to be effective. A trend toward background channel morphology, however, is expected over the long term. Consequently, this alternative is considered to be less than significant and beneficial with regards to channel morphology.

Section 3.6, Soils and Geomorphology, discusses the risk of coarse sediment influx from timber harvest- and road-related mass wasting. The risk under this alternative was determined to be moderate (i.e., less than significant for CEQA purposes). The potential for significant aggradation and related increases in flooding is also considered to be moderate for this alternative. Therefore, the potential effects of flooding on people and property are also less than significant.

The potential for increases in peak flows related to roads has primarily been demonstrated for small to mid-size flows (Jones and Grant, 1996). Under normal channel conditions these potentially small increases would not cause overbank flooding. However, in aggraded channels, small increases in peak flows may cause overbank flooding. In the aggraded channels of the five cumulatively affected watersheds, there is some potential for minor overbank flooding related to road-related peak flow increases. The actual extent or magnitude of such flooding is speculative and unknown. The potential for further aggradation due to increases in sediment is discussed in Section 3.6, Soils and Geomorphology.

Alternative 2a (No Elk River Property)

Over most of the Project Area, the effect of this alternative on channel morphology would be identical to that under Alternative 2. The only area where effects would be different is in the Elk River HU. Here, it is assumed that the Elk River Timber Company, like other adjacent timber companies, would be required to have the same buffers as under Alternative 1, which are the default, “no-take” buffers. Stream channels in the Elk River HU would, thus, receive more protection for streambank stability than under Alternative 2.

Alternative 3 (Property-wide Selective Harvest)

This alternative would allow for more rapid recovery of the aquatic system in the Project Area than Alternative 2. The wider no-cut buffers would protect or increase streambank stability for both wide and narrow streams. Additionally, a relatively large amount of late-seral forest would be preserved through the establishment of MMCAs and no-harvest RMZs, providing substantial protection against increased coarse sediment influxes. Property-wide selective harvest would decrease the potential for shallow-rapid landslides and coarse sediment delivery to streams. Implementation of a road management plan would reduce road-related mass wasting coarse sediment inputs (see Section 3.6). LWD recruitment potential would trend toward background levels, and would, over time, help to stabilize stream channels. Furthermore, in the watersheds identified as having cumulative effects from current and past forest practices, the requirement of no net sediment discharge would cause a rapid trend toward background sediment influx in those watersheds. There would be some short-term effects on channel morphology due to road failures and timber-harvest-related mass wasting; however, the trend toward properly functioning conditions would be relatively rapid. Consequently, this alternative is considered to be less than significant, and beneficial, with regards to channel morphology. The potential for significant aggradation and related increases in flooding is also considered to be low to moderate for this alternative. Therefore, the potential effects of flooding on people and property are also less than significant.

The potential for increases in peak flows related to roads has primarily been demonstrated for small to mid-size flows (Jones and Grant, 1996). Under normal channel conditions these potentially small increases would not cause overbank flooding. However, in aggraded channels, small increases in peak flows may cause overbank flooding. In the aggraded channels of the five cumulatively affected watersheds, there is some potential for minor overbank flooding related to road-related peak flow increases. The actual extent or magnitude of such flooding is speculative and unknown. The potential for further aggradation due to increases in sediment is discussed in Section 3.6, Soils and Geomorphology.

Alternative 4 (63,000-acre No-harvest Public Reserve)

This alternative would provide substantial protection of stream channels. Outside the Reserve, the trends toward background conditions would be similar to Alternative 2. Within the Reserve, protection against coarse sediment influx would be high, since no harvest would occur over 63,000 acres. LWD recruitment would increase over time to near pre-harvest conditions.

In the short term, effects to channel morphology would continue, as the stream system responds to past activities. In the Reserve, short-term effects from road-related mass wasting could cause localized channel aggradation and associated lateral erosion. The trend toward background conditions would occur, while there would be a moderate risk of channel change in the short term outside the Reserve.

As under Alternative 2, the risk from timber-harvest- and road-related mass wasting was determined to be low to moderate (i.e., less than significant). The potential for significant aggradation and related increases in flooding are also considered to be low to moderate for this alternative. Therefore, the potential effects of flooding on people and property are also less than significant.

The effect of this alternative on flooding within the five cumulatively affected watersheds is expected to be the same as under Alternative 2, significant, as these watersheds would not be within the Reserve.

The short-term effects of this alternative on flooding within the Reserve are expected to be significant only on those watersheds with the highest road densities. These effects would be negligible in the long term.

3.4.3.6 Gravel Mining —All Alternatives

Proposed gravel mining operations are identical among the alternatives; therefore, the effects of gravel mining would be the same. PALCO has gravel mining permits for 10 sites along the Eel River between Scotia and Whitlow (Table 3.4-6). The method of gravel extraction is skimming, which incrementally removes horizontal sections of a gravel bar; however, other methods may be employed for specific purposes, such as fish habitat enhancement. Other possible methods include parallel trenching and pit mining (PALCO, 1995).

According to PALCO's Reclamation Plan (PALCO, 1995), the mining operations are to be a minimum of one foot higher than the mean low flow channel. The maximum depths of extraction are established in the Reclamation Plan (PALCO, 1995). The difference between the maximum, or "redline," depth and the depth of the thalweg (the deepest portion of the channel) is typically zero to two feet. The total depth of mining varies, depending on how much gravel is deposited on the gravel bars during the high flow season. Since the redline depth is relative to water elevation, the depth of mining depends on the summer flow volume.

The projected average rate of gravel extraction per site is 15,000 yd^3/yr, although the total extraction from all PALCO sites is limited to 160,000 yd^3/yr, and is limited at each site to no more than 30,000 yd^3/yr. This level of extraction, combined with extraction at non-PALCO sites, is within typical bedload transport rates through this section of the Eel River. Therefore, no net degradation of the streambed should occur. A slight positive effect on storage of flood flows would occur by increasing the floodplain capacity in the immediate vicinity of the gravel bars.

Gravel bars disturbed during seasonal gravel extraction would be restored to the approximate planform and shape before winter (PALCO, 1995). Reclamation would be conducted according to CDFG 1603 requirements. The term of the Reclamation Plan is 25 years from the date of approval. Reclamation of several existing access roads to the various gravel bars and one stockpiling area is proposed as part of the Reclamation Plan. The area is about 5 acres.

Should trench or pit methods be used (a possibility under the Reclamation Plan), stream erosion could migrate upstream from the pit. This process is known as knickpoint retreat. If knickpoint retreat occurs, structures such as bridges and piers could be affected, through undermining of their pilings. Additionally, spawning habitat could be affected directly by scour (Collins and Dunne, 1989). However, such extract methods would be subject to CDFG requirements, and it is expected that this potential effect would be mitigated.

One potential negative effect of gravel mining is the alteration of riparian vegetation. Currently, the gravel bars along the Eel River are wide and unvegetated; the channel aggraded during extreme storm events of the 1950s and 1960s, and is probably still recovering. Gravel mining would prevent vegetation from colonizing gravel bars. It is possible that the channel of the Eel River would become more stable over time if gravel mining did not occur, as trees encroached on the streambed. However, the influence of upstream processes (timber harvest, urbanization, livestock grazing) could prevent vegetation from becoming established on gravel bars regardless of gravel mining. Continued large sediment influx during floods could strip vegetation from the streambanks. Any potential negative effect on riparian vegetation would be mitigated only by prohibiting gravel mining. Overall, the area affected is small.

3.4.3.7 Summary of Effects

The effects of each action alternative are summarized in Table 3.4-6. This table shows, in simplified terms, the trends which affect the water quality and quantity portions of the aquatic system.

Alternative 1 (No Project/No Action)

This alternative would have an overall slight effect on water quantity in some watersheds. In most watersheds there would be little if any effect on either peak flows or summer low flows.

Water quality would continue to be affected by fine sediment, coming mostly from roads and through mass wasting. Because of the importance of these sources, the overall effect on turbidity and suspended sediment is that the water quality standard would continue to be exceeded. Standards for nitrates, temperature, and herbicides would not be exceeded in the long term; however, stream temperatures could remain elevated in those areas still recovering from past riparian timber harvest and in those areas where summer stream temperatures are naturally high.

Floodplains and channel morphology would be affected under this alternative. Although there would be continued input of coarse sediment from road-related mass wasting, coarse sediment from timber harvest-related mass wasting would be substantially reduced.

Alternative 2 (Proposed Action/ Proposed Project)

This alternative would have essentially no effects on peak flows or low flows. Because the road stormproofing and adoption of the road handbook would decouple many roads from the stream system, accelerated flood peaks in small watersheds would be less likely. Timber-harvest-related flow effects would be negligible.

Water quality would improve under this alternative, because of the various measures taken to prevent road surface erosion and mass wasting. The effects of herbicides would be negligible, due to the mitigative measures applied.

This alternative would offer substantial upslope protection for the aquatic system. The evaluation and prescriptions required for areas subject to mass wasting, and the required road management practices would significantly reduce the number of associated landslides. The resulting decrease in coarse sediment input would cause a trend toward background channel morphology. LWD inputs would also increase, which would also help stabilize channel pattern and local elevation.

Alternative 3 (Property-wide Selective Harvest)

This alternative would have minimal effects on peak and low flows, due to the amount of land held in the various types of reserves and due to the selective harvest prescription. The RMZs, selective timber harvest, and road maintenance program would maintain water quality objectives. Selective timber harvest and the road maintenance program would substantially reduce coarse sediment influx. Combined with increased LWD availability and streambank protection, channel morphology would be maintained or improved.

Alternative 4 (63,000-acre No-harvest Public Reserve)

This alternative would have virtually the same effect on the aquatic system as Alternative 2, except within the Reserve. Water quality and channel morphology would be maintained or improved as in Alternative 2. Any existing increased peak flows in the Reserve would slowly diminish, resulting in a rapid trend toward background conditions. Because the Reserve represents a substantial portion of the Project Area, regional risk of adverse change to water quality and channel morphology would be reduced to low to moderate.

3.4.3.8 Mitigation

In the Draft HCP, the applicant provided the suggested minimization and mitigation measures that have been analyzed in the

Draft EIS/EIR and, for CEQA purposes, in the Final EIS/EIR as resulting in less than significant effects to affected resources except with respect to wet-weather road use and winter road construction and reconstruction activities. However, after reviewing and evaluating public comments on the Draft EIS/EIR in light of FESA and CESA permit issuance criteria, the wildlife agencies have determined that additional measures are appropriate to minimize and fully mitigate the impacts of take and to further reduce potential adverse effects. The complete package of minimization and mitigation measures is presented in the proposed HCP's Operating Conservation Program in Appendix P. The additional mitigation measures are intended to reduce the delivery of road- and timber-harvest-related sediment to the drainage network to protect the beneficial uses of the water, including aquatic habitat. Additional mitigation has been added for (1) sediment assessment, (2) road stormproofing, (3) road construction, reconstruction, and improvement, (4) road inspections, (5) wet weather road-use restrictions, (6) hillslope management, and (7) riparian buffers. The following summarizes the additional mitigation measures:

Sediment Assessment—A sediment assessment of the existing road network and associated sediment sources will be conducted according to Pacific Watershed Associates protocols (July 1998 Draft HCP, Volume II, Part O, with attachments) and completed within five years as part of the watershed analysis, or within five years of the planned stormproofing.

Road Stormproofing—The additional mitigation for stormproofing will expedite the reduction in road-related sediment delivery to the aquatic system. The time frame for stormproofing has been reduced from 30 years in the Draft HCP to 20 years in the Final HCP. Within the first 20 years of the plan, all roads will be stormproofed to the standards identified in Weaver and Hagans (1994) at a minimum rate of 750 miles per decade and 75 miles per year. Highest priority sites will be addressed first.

Road Construction, Reconstruction, and Improvement—All mitigation related to road construction in the Draft HCP also applies to road reconstruction. The wet weather road construction that was determined to exceed the threshold of significance in the EIS/EIR will be mitigated to a level of less than significance with the following prescriptions:

- Road or landing construction and reconstruction shall not occur during the wet weather period, defined for this purpose as October 15 to June 1, unless the following conditions are met:
  - No road or landing construction and reconstruction may occur within 170 feet of a Class I or II watercourse, or within the EEZ (50 feet or 100 feet, respectively) of a Class III watercourse.
  - The construction and reconstruction shall not/will not cross a Class I, II, or III watercourse
  - The construction/reconstruction does not/will not cross an inner gorge, headwall swale, unstable area, or an extreme, very high, or high mass-wasting hazard area.
  - The soil moisture content in the soils moved for construction/ reconstruction purposes shall be no wetter than is found during normal watering (dust abatement) treatments or light rainfall, and must not rut or pump fines.
  - During and after construction and reconstruction, there shall be no visible increase in turbidity in any drainage facility, construction/reconstruction site, or road surface, any of which drain

directly to a Class I, II, or III watercourse (standing water on the road which does not drain to a Class I, II, or III watercourse is not applicable).

- During construction and reconstruction, erosion control material of sufficient quantity shall be stockpiled on the site and used to prevent an increase in turbidity in any drainage facility, at any construction/reconstruction site, or on any road surface, any of which drain directly to a Class I, II, or III watercourse.

Road Inspections—The road inspections/monitoring are intended reduce the potential for adverse sediment delivery and road failures to streams. The additional mitigation for road network monitoring includes closing and decommissioning roads and landings that cannot be inspected according to guidelines provided by Weaver and Hagans (1994).

Wet Weather Road Use Restrictions—Wet weather road use restrictions are intended to comply with water quality objectives and reduce the potential for adverse impacts of fine sediment delivery from road surface erosion. The additional mitigation includes no road use when precipitation is sufficient to generate overland flow off the road or when it is capable of leaving the road. In addition, specific restrictions on wet-weather, non-paved road use would also reduce road-generated surface erosion.

Hillslope Management—Additional mitigation was included in the hillslope management prescriptions to further reduce the risk of coarse and fine sediment delivery to streams in mass-wasting areas of concern. The major mitigation measures include the following:

1. No harvest shall be allowed on the mass-wasting areas of concern until watershed analysis indicates if and where harvest is appropriate.

2. Watershed analysis determination for road construction and timber harvest in mass wasting areas of concern will include an assessment of risk to the aquatic environment by a qualified aquatic biologist in the watershed analysis process.

3. A scientific panel established by the wildlife agencies and PALCO will evaluate and potentially modify the definitions of high, very high, and extreme mass-wasting areas of concern. In addition, the federal agencies, in consultation with state agencies, will provide a set of criteria to determine whether mass-wasting events are to be considered significant for aquatic resources for use in the mass-wasting watershed analysis module.

Riparian Buffers—Require RMZs along Class III streams. These RMZs will be 50 feet wide on each side of the stream on slopes less than 50 percent and 100 feet wide on slopes greater than 50 percent. They will consist of an inner, 30-foot-wide, no-harvest zone and an outer sediment filtration band. This additional mitigation will provide the following protection:

1. Reduce the delivery of any fine sediment from overland flow near these streams.

2. Maintain more LWD in Class III streams. This will reduce sediment transport and minimize the potential for gullying in these channels.

3. Reduce the risk of mass wasting and the associated delivery of both coarse and fine sediment to downstream Class II and I streams.

3.4.3.9 Cumulative Effects

This section discusses the cumulative impacts of the HCP and other future actions that may occur in the watersheds of the Project Area that are not PALCO related. Future actions that would affect water quality within the watersheds of the Project Area include watershed management planning, other HCPs by industrial timber owners, FPRs with coho considerations, and the development and implementation of TMDLs (see Water Quality in Section 3.6).

The NCRWQCB is responsible for enforcing the Basin Plan water quality objectives and maintaining the quality of water for beneficial uses. As discussed in Section 3.6, the Basin Plan states that when other factors result in the degradation of water quality beyond the levels or limits established by the NCRWQCB, then controllable factors shall not further degrade water quality. Controllable water quality factors are those actions, conditions, or circumstances resulting from management activities that may influence the quality of the waters of the state and may be reasonably controlled.

Watershed Management

The NCRWQCB is in the process of drafting a watershed management initiative (WMI) plan. The WMI would be a multi-phase approach to address water quality issues in wetland management areas (WMAs) of the North Coast. The WMAs that encompass the Project Area include the Humboldt Area WMA, Eel River WMA, and the North Coast Rivers WMA which includes the Bear River and Mattole River watersheds. Within each WMA, the plan would involve assessing water quality issues on a watershed basis, developing prioritized water quality goals for watersheds from the issues, addressing the issues with various programs through a multi-year implementation strategy, and evaluating progress at the end of a specified time period (NCRWQCB, 1998). For the purpose of this analysis, the draft WMA boundaries will be used to discuss cumulative effects.

As discussed in Section 3.6, under Water Quality, many of the streams in the Project Area have been listed as water quality impaired under Section 303(d) for sediment and/or temperature, including Mad River, Freshwater Creek, Elk River in the Humboldt WMA, the Eel River, the Van Duzen River, and Yager Creek in the Eel River WMA, and the Mattole River for sediment in the North Coast Rivers WMA. One of the major land use activities that has contributed to the water quality impairment has been timber harvest; the NCRWQCB has issued enforcement actions on THPs in violation of Basin Plan standards in all of these WMAs (NCRWQCB, 1997).

TMDLs, as discussed in Section 3.6 under Water Quality, are required for water quality impaired waterbodies listed under Section 303(d). The development of TMDLs is a multi-step process. A problem statement is developed to describe why and how the water quality impairment fails to support beneficial uses. Numeric targets are developed to describe instream water quality goals or desired future conditions necessary to support beneficial uses. A source analysis is conducted to describe the amount and source of the impairment, such as the source and quantity of sediment delivered to the stream. A linkage analysis is conducted to describe the relationship between the source of the impairment and existing instream conditions to determine how much of the specific parameter such as sediment has to be reduced to achieve desired conditions. Allocation of responsibility assigns loads to land use based on existing and historical activities and identifies associated land management measures necessary to achieve numeric targets or desired future conditions. An implementation plan describes how the needed reductions will be achieved in conjunction with an implementation schedule. A monitoring plan is also developed to track the success in meeting numeric targets. The last step is development of a plan for future review of the strategy. The proposed Garcia River (CA) TMDL (NCRWQCB, 1998) is an example of the TMDL framework used to reduce sediment in a watershed.

The EPA has created an index to overall watershed health. This Index of Watershed Indicators (IWI) is based upon current conditions and future vulnerability. The EPA and its partners selected 15 separate water quality indicators to create an index of water quality on a watershed basis. The index rates watersheds on a score of 1 to 6, with 1 indicating better water quality and 6 indicating serious water quality problems (http://www.epa. gov/surf/IWI, 1997). Although the data used to determine the index range from inconsistent to consistent, it is some of the best available information to address current watershed conditions across the North Coast region.

HUMBOLDT WATERSHED MANAGEMENT AREA

The Humboldt WMA includes the Humboldt Bay WAA and the Mad River WAAs. Water quality issues in the Humboldt WMA center on domestic water supply, the anadromous fishery, and recreation. Point source pollution concerns include pollutant-laden urban runoff, river gravel mining, and local sewage treatment plant compliance problems. The upper areas of the WMA are primarily in timber production and harvesting. In the Humboldt Bay WAA, 48,000 acres of THPs are either ongoing or recently completed, including PALCO lands. Increased stream sedimentation from past management practices and continued problems with harvesting techniques and road construction have affected all drainages in the WMA, but to varying degrees (NCRWQCB, 1998). Non-point source pollution issues concerning the coldwater fisheries of the WMA include sedimentation from rural subdivisions in the downstream areas of the watershed and logging roads as upstream sources of sediment (NCRWQCB, 1998).

In the Humboldt Bay WAA, the major land uses are community (54 percent) and timber (44 percent); in addition, Freshwater Creek and Elk River have been listed as water quality impaired under Section 303(d). These streams have been listed as medium priority for TMDL completion. TMDL completion dates are the years 2009 and 2010 for Elk River and Freshwater Creek, respectively. CDF has also listed these watersheds (Elk River HU) and Freshwater Creek watershed (Freshwater Creek HU) as cumulatively impacted by sediment. The future timber lands management in these specific drainages will reduce controllable sediment. PALCO owns 66 percent of the Elk River HU and 56 percent of the Freshwater Creek HU. These watersheds and management of their lands under the HCP would have a positive cumulative effect, though persistence of historical management-related sediment would continue to adversely affect beneficial uses; management under the HCP and the CDF THP review would reduce sedimentation in the HUs.

Under Alternative 4, approximately 24,800 acres of the Humboldt Bay WAA would have additional no-harvest protection as part of the 63,000 acre Reserve. The Reserve would result in less management-related sediment delivery in its locality, and stream temperatures would improve in areas that may be currently degraded.

The Mad River WAA is primarily mixed private and USFS timberland. In addition to the long history of timber harvest, gravel mining operations exist in the lower portions of the WAA. The Mad River is Section 303(d) listed for temperature and sediment impacts. The primary land uses for the watershed are forestry-related (49 percent), with urbanization and associated industrial and public point sources of pollution. The Mad River is the drinking water and industrial water supply for the Humboldt Bay Area, and other coastal streams provide drinking water for local communities and homes. PALCO owns less than five percent of the watershed. The effect of the HCP in combination with other landowners would reduce the "controllable" delivery of sediment to streams compared to current conditions. Until the development and implementation of TMDLs in this watershed by other landowners, PALCO management would have little effect on reducing management-related sedimentation in the Mad River WAA. TMDL implementation, which may include a basin implementation strategy, or private ownership sediment reduction plans, such as HCPs, would cumulatively improve water quality over the next 20 years. However, until TMDL implementation, there may still be adverse effects on the aquatic and hydrologic systems of the Mad River watershed. TMDL implementation strategies by other landowners should improve water quality over time as designated in the TMDL development strategy for the Mad River watershed. The time necessary to meet TMDL targets is presently unknown because few TMDLs have been completed and implemented to this date.

The EPA IWI for the Mad-Redwood Basin includes the Mad River WAA and Humboldt Bay WAA. The Mad-Redwood Basin was rated as having less serious water quality problems, but high vulnerability to stressors such as pollutant loadings (Table 3.4-8) (http://www.epa.gov/surf/IWI, 1997). The timber land management in the upper parts of the watershed has a direct effect on the water quality of the most populated WAA in the watershed. The HCP and other sediment reduction measures such as zero net discharge in the cumulatively impacted HUs should gradually improve water quality and its beneficial uses in the upper parts of the watershed. However, water quality improvements in the upper portions of the WMA (e.g., timberlands) may be muted by the urbanization and agriculture in the lower portions of the WMA. Continued population growth and its stresses on the waters may negate the effects of improved timberland management in this WMA.

EEL RIVER WATERSHED MANAGEMENT AREA

The Eel River WMA encompasses approximately 3,684 square miles and includes the Eel River, its forks, the Van Duzen River, and Yager Creek. The Eel River watershed supports a variety of uses including municipal and agricultural water supply systems, salmonid fisheries, and recreation. The Eel River is the third largest producer of salmon and steelhead in the state of California. The main watershed issues concerning fisheries include stream sedimentation from commercial timberlands and grazing, herbicide application, dams, and gravel mining (NCRWQCB, 1998).

Point source pollution concerns include numerous maintenance yards in the watershed from various land owners, numerous junk yards throughout the watershed, solid waste disposal including fly ash, the diversion of waste streams to reduce materials disposal volumes, and a concern over the continued operation and maintenance of wastewater treatment plants and the associated ponds in the floodplain especially regarding contact recreation (NCRWQCB, 1997).

Non-point source pollution concerns include the dairy industry and grazing impacts to the watershed from direct discharges of waste and/or whey, animals in the creeks and waterways, trampling of the banks, and other seasonal mechanisms. Increased sedimentation rates have changed channel morphology. Sedimentation of small streams in the Eel River Delta has caused localized flooding and accelerated erosion in some cases from redirected stream channels, and a large portion of the watershed supports commercial timberlands. Approximately 160,000 acres of THPs (107,000 acres in the Eel WAA, 18,000 acres in the Van Duzen WAA, and 35,000 acres in the Yager WAA) are either ongoing or recently completed, including PALCO lands. Concern has been raised regarding the past and present impacts of timber harvest. TMDL development in this watershed is a low priority with TMDL completion dates ranging between 2006 for the Eel Delta and 2002 for the North Fork Eel River (NCRWQCB, 1997).

PALCO owns only three percent of the entire watershed, but effects from PALCO management under the HCP would be most pronounced in the Eel WAA (17 percent PALCO ownership), Van Duzen WAA (41 percent PALCO ownership), and the Yager WAA (40 percent PALCO ownership). Because of the low priority TMDL completion for these areas, the implementation of the HCP sediment management plan and RMZs would reduce sediment delivery to streams and maintain and improve temperatures specifically in the Van Duzen and Yager WAAs. Management-related improvements in riparian protection and sediment control by Under Alternative 4, approximately 1,300 acres in the Van Duzen WAA, 33,600 acres in the Yager WAA, and 3,900 acres in the Eel WAA would be part of the 63,000 acre Reserve. The Reserve would result in less sediment delivery to streams because of its no-harvest status, and stream temperatures would improve in places where it is currently degraded.

In the Eel River WAA, CDF has listed the Jordan Creek watershed (Lower Eel HU), Stitz Creek watershed (Lower Eel HU), and Bear Creek watershed (Lower Eel HU) as cumulatively impacted by sediment. The EPA data indicate watershed conditions in the Eel WMA worsen downstream, especially in the Eel Delta watershed (Table 3.4.8). The USGS-EPA Lower Eel watershed boundary includes the Eel River WAA, Yager WAA, and Van Duzen WAAs of the Project Area. The other timberland owners are assumed to have similar sediment reduction management as PALCO because of the FESA listing of the coho salmon. In addition, the development of TMDLs which may include a basin implementation strategy, or private ownership sediment reduction plans such as HCPs, should cumulatively maintain and potentially improve water quality over the short to long term. However, the amount of time necessary to meet TMDL targets is unknown.

NORTH COAST RIVER WATERSHED MANAGEMENT AREA

North Coast rivers not specifically included in other WMAs are included in this grouping. Two of the 12 rivers in this WMA that include the Project Area include the Bear and Mattole rivers. The principal threats to water quality in the Mattole watershed consist of non-point source pollution such as road-related sedimentation, industrial and non-industrial timber harvest (29 percent of the land use), cattle and sheep ranching (36 percent of the land use), concentrated wastes associated with four public school institutions, and individual and household wastes (Mattole Restoration Council, 1995). In the Bear River, the principal management-related threats to water quality include timber production

(49 percent of the land use) and grazing (49 percent of the land use). In the Bear-Mattole WAA, 17,000 acres of THPs are either ongoing or recently completed, including PALCO lands. The EPA IWI for the Mattole watershed rates the water quality as less serious water quality problems with a low vulnerability to stressors such as pollutant loadings (http://www.epa.gov/surf/IWI, 1997). TMDLs will be developed by the year 2002 to address the CWA 303(d) listing of the Mattole River as water quality impaired for temperature and sediment. PALCO only owns nine percent of the Mattole River watershed. Consequently, HCP implementation would reduce, though not substantially, sediment and maintain or improve stream temperatures in the upper part of the watershed. In addition, the cumulative effect of the development of TMDLs by all landowners which may include a basin implementation strategy, or private ownership sediment reduction plans such as HCPs would cumulatively maintain and potentially improve water quality over the next 20 years. However, until TMDL implementation, the recovery of the aquatic and hydrologic systems of the Mattole River systems may be impacted. The implementation of TMDL by other landowners should improve water quality over time.

In the Bear River, PALCO owns approximately 25 percent of the watershed. The management under the HCP would improve delivery of controllable sediment to streams and maintain stream temperatures, especially in the headwaters of the watershed where PALCO ownership is relatively consolidated. Other timberland ownership is assumed to have similar sediment reduction measures as PALCO. However, grazing accounts for almost 50 percent of the land use designation. Grazing impacts, especially near watercourses, may impede any water quality improvements made by timberlands management. Because this river is not listed as water quality impaired, there would be no TMDL development.

3.4.3.10 Additional Mitigation

After reviewing and evaluating public comments on the Draft EIS/EIR in light of FESA and CESA permit issuance criteria, the wildlife agencies have determined that additional measures are appropriate to minimize and fully mitigate the impacts of take and to further reduce potential adverse effects. The complete package of minimization and mitigation measures is presented in the proposed HCP's Operating Conservation Program in Appendix P. The additional mitigation measures are intended to reduce the management-related cumulative effects on watershed processes, such as the hydrologic system, the riparian system, and aquatic habitat. The synergistic effects of land management activities are displayed in Figure 3.1-1. The major cumulative effects mitigation is described in Section 3.4.3.10.

Table 3.4-8. IWI for Watersheds in the North Coast Region

WMA	Watershed	IWI Score	Conclusion
Eel River	Upper Eel	3	Less serious water quality problems, low vulnerability to stressors such as pollutant loadings
	South Fork Eel	3	Less serious water quality problems, low vulnerability to stressors such as pollutant loadings
	Middle Fork Eel	Insufficient Data	
	Lower Eel	5	More serious water quality problems, low vulnerability to stressors such as pollutant loadings
Humboldt	Mad-Redwood (includes Arcata and McKinleyville)	4	Less serious water quality problems, high vulnerability to stressors such as pollutant loadings
North Coast Rivers	Mattole-Bear	3	Less serious water quality problems, low vulnerability to stressors such as pollutant loadings

Source: Foster Wheeler Environmental Corporation